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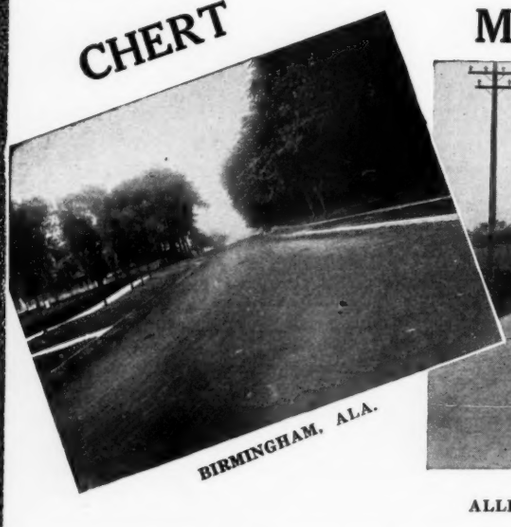

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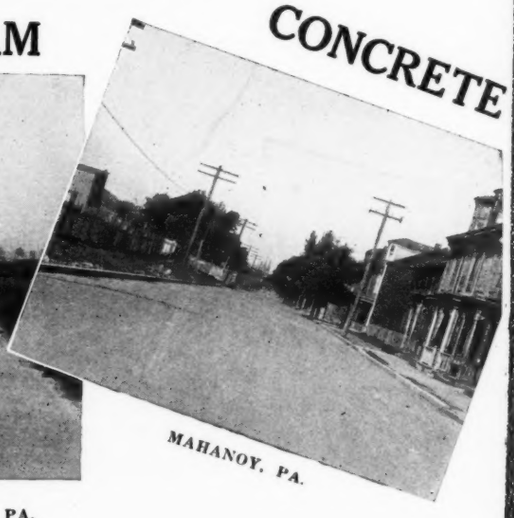

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City officials and civic organizations are particularly requested to send to Municipal Journal and Public Works regularly their annual and special reports.

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OUR ANNUAL STATISTICAL NUMBER.

In this issue we publish, according to our established custom, a report for 1919 on certain features of waterworks practice. This year we have paid special attention to meter reading and maintenance, meter rates and fire protection charges, and office methods including the use of labor-saving appliances in the office. The universality of the interest that this should have for waterworks men is indicated by the fact that more than 98 per cent of the plants report the use of meters.

In almost equally as general practice is the sterilizing of water, and the symposium of data on this rapidly developing feature will undoubtedly prove valuable to all.

PROTECTION AND IMMUNITY FROM TYPHOID.

A prominent sanitarian, in discussing typhoid fever with the writer, remarked that he had recently visited his childhood home and renewed the surprise that occasionally came over him that he had ever survived that childhood; for he found there many of the conditions which his present knowledge told him were almost sure, sooner or later, to spread typhoid fever. Asked how he and his family and neighbors had escaped it, he replied that the answer was, in his opinion, two-fold: Immunity and they didn't. He believed it extremely probable that most babies living under such conditions contracted typhoid in a more or less mild form; the robust ones recovered, the weaklings died. Probably most of the children that survived had several attacks and acquired a cumulative immunity which protected them for the rest of their lives.

There are several points arguing for the correctness of this opinion. Millions of people in Asia and Europe escape typhoid under conditions that would surely breed a pestilence in this country, and the only apparent reason is immunity, both inherited and personally acquired. Again, removal of dangerous conditions, decrease of immunity, and a decrease of more than fifty per cent in the infant death rate, have progressed together; the survival of infants not subjected to typhoid and therefore not immune probably being the cause and effect that connects these three facts.

If this be a true diagnosis, then we as a nation, by minimizing danger of typhoid, are lessening our immunity and thus rendering ourselves more subject to epidemics if at any time the protection should be withdrawn. This might be used as an argument against anti-typhoid precautions; but the answer to this is that by such precautions we save millions of children who would otherwise die in carrying out the immunity program. Also the race probably is lessening its resistive powers through

many of the changes of mode of living that are part of modern civilization; and we are not ready to abandon these, also. In fact, an important change, increasing density of population, can not be removed except by a long-continued world war or by pestilence.

More protection, not less, is the only defensible course. If we are becoming more susceptible to typhoid, then we must take more precautions against chance typhoid infection. One of the most important moves is to reduce the waves of "summer typhoid" that are due to unsanitary conditions at summer resorts and summer homes; to the "old oaken bucket" from which the automobilists drink along the roadside. This must generally be attended to by state health boards, and it is most important at this time that in every state of the Union more power be given to and wisely exercised by such boards.

LOUISVILLE'S NEW PUMPING STATION

To House Latest Increase to Pumping Plant—Thirty Million Gallon Vertical, Triple Flywheel Pump —Contractor's Methods and Plant Used in Sinking Caisson and Erecting Building.

Louisville, Kentucky, draws its water supply from the Ohio river, on the bank of which are located the pumps which raise it to the filtration plant on Crescent Hill. The plant had been enlarged a few years ago, but the increase in consumption had practically caught up with that in the pumping capacity during 1917, and another increase in the latter was found to be necessary.

The maximum theoretical pumping capacity of the plant at the river is only 70 million gallons in 24 hours and the real maximum attained is about 56 or 58 million gallons with all pumps going, even after the completion of a new 48-inch rising main. During occasional periods of a few hours each there has been a consumption by the city at the rate of more than 70 million gallons. While the city has a good reservoir capacity, had any of the pumping units been compelled to shut down for any length of time by an accident, the whole water system would have been seriously incapacitated.

To meet this condition, a contract was entered into last year for a new Allis-Chalmers pump, vertical, triple-expansion, crank and fly wheel, of 30 million gallons capacity. A few years ago one of the two pumping stations at the river had been arranged to receive an additional 30-million-gallon turbine centrifugal pump; but the pump of this type already in operation lifted only 220 gallons of water per pound of coal last year, as compared with 650 to 700 gallons pumped by the reciprocating engines operating under the same conditions and, chiefly on this account, it was decided not to install the second turbine centrifugal pump originally provided for, but to secure a vertical crank-and-flywheel pump, for which a new building was necessary.

In designing the new pumping station, there were kept in mind the needs for future increase in capacity, for more efficient screening facilities than at present, and for the most convenient location with reference to the intake and suction line. An intake tower had been completed in the river in 1914 and it was found that a new station could be located near the two old ones and obtain water conveniently through this intake tower. It was accordingly located on the east side of station No. 2 and made very similar to it in appearance and symmetrically located with reference to the intake tower. By this location it was possible to so build a cofferdam used for constructing the new station that the connecting of the new intake lines to the old suction could be performed inside of this cofferdam.

The station was planned and constructed so as to provide for two 30-million-gallon vertical pumps, although only one is being installed at present.

In addition to the pumping plant, there is being constructed a new boiler house, to contain six 400 H. P. water-tube boilers with chain grates, soot blowers, and superheaters, and a complete coal-handling and storage system whereby the coal will be unloaded automatically from railroad cars, crushed and conveyed to bins above the boilers. Two boilers were purchased from the Henry Vogt Machine Co. in November, 1917, provided with Illinois chain grate stokers, Vulcan soot blowers and Foster superheaters, but the war prevented delivery until October, 1918. Meantime two more boilers had been purchased from the Babcock & Wilcox Co., to be delivered in March, 1919.

The Vogt boilers were erected just outside the west walls of the existing boiler house and covered with a temporary wooden shed, while plans were being prepared for a new boiler house. Bids were received for this house in November, 1918, but were so high that the board decided to build the structure on a cost-plus-percentage basis, the work being given on that basis to the contractors for the pumping station, who began work on the excavation last December. It is expected to finish the boiler house this season at a cost of about $175,000.

Pumping station No. 2 and the new station stand side by side, about 40 feet apart in the clear, on the south bank of the river. They are connected by an enclosed bridge or passageway at the main floor level. The new station consists of a sub-structure about 80 feet square resting on a caisson 90 feet square and supporting a superstructure 75 feet square, on which is a pyramidal roof with slopes of 45 degrees. A bridge 70 feet long connects the main floor of the building with the embankment to the south, affording access and also carrying the discharge mains (two 42-inch pipes) and the steam pipes.

North of the main substructure, between it and the river, is a suction well, the pump well being a dry well, in which respect it differs from the old pumping station. In the suction well are supplementary screens with provisions for cleaning them, valves for controlling the distribution of the intake water, and a small traveling crane to raise and lower the screens for cleaning or repairs. These screens permit a more efficient screening of the intake water, excluding the mud and rubbish from the main pump pit. In the main building is a 30-ton crane which spans the whole engine room, provided for installing the heavy pump parts and handling them later for repairs; the crane being used also by the contractors for removing their equipment from the building and installing the main floor.

The caisson is 33 feet deep, and is covered with two feet of reinforced concrete floor forming the bottom of the main pump pit. The suction well extends 10½ feet below this into the caisson. Entering the north wall of the suction well are four 36-inch intake pipes, each of which carries a 36-inch double-disc gate valve which is electrically operated and controlled from the screen room above. Just outside the suction well, these four pipes connect in pairs to two 48-inch pipes leading from the intake tower.

The substructure is 49 feet high and contains no openings, as the river has been known to rise to nearly the level of its top. In order to resist the pressure of flood water on these walls, the plan was adopted of making the interior of the substructure circular and the outside square, the corners being cored out with a circular well 9 feet in diameter at each corner. The concrete walls were reinforced with 1-inch deformed steel bars, both horizontal and vertical, spaced about 18 inches on centers, at both inner and outer surfaces, the principal functions of which are to prevent shrinkage or settlement cracks which would let in water and to stiffen the arch ring. The top twelve feet of the substructure consists of plain walls 4½ feet thick. The substructure was faced on the outside with pitch-faced stone ashlar corresponding to old station No. 2.

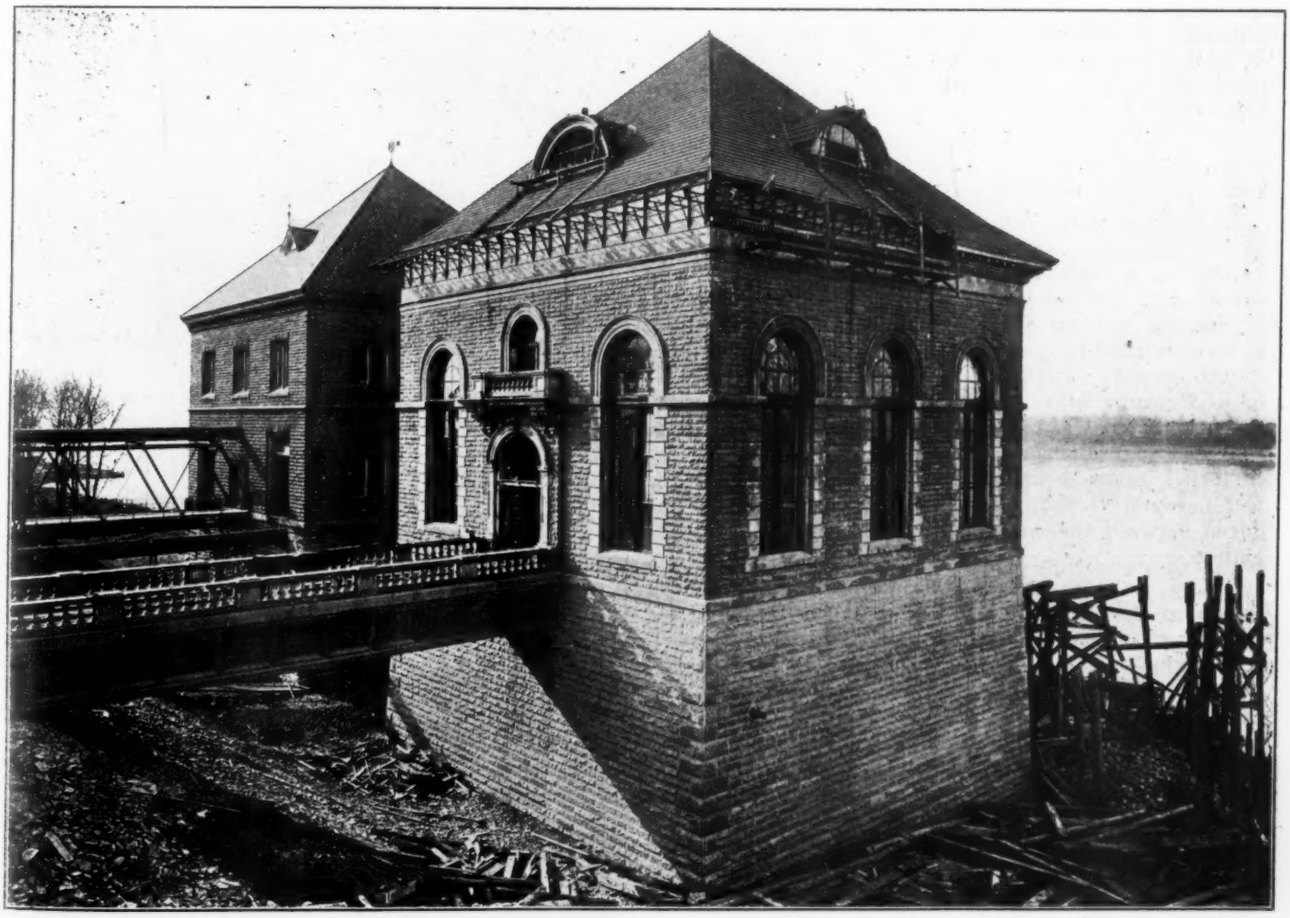
The superstructure consists of reinforced concrete walls with a 6-inch veneer of pitch-faced ashlar and containing nine large windows and a large entrance door on the main room, and two windows in the screen room bay at the north and a door in the north wall opening onto a small balcony that overlooks the river. The roof is covered with red tiles of the interlocking type. A steel frame balcony with a concrete slab floor encircles the engine room 24½ feet above the floor; the balcony being 3 ft. 10 in. wide except at a few points where it is 5 ft. 4 in. A spiral stairway connects the balcony with the main floor and continues down into the pump pit.

The passageway connecting the new station with No. 2 consists of a concrete slab and tile floor, hollow terra-cotta tile walls faced with thin stone ashlar on the outside, and a reinforced concrete flat slab roof, all supported by two steel girders 43 feet long and 19 ft. 6 in. between centers, encased with a 3-inch facing of concrete with moulded panels. These girders were calculated to carry 100 pounds per square foot of floor in addition to the dead weight.

The contract for the building was let in October, 1916, to the Fruin-Colnon Contracting Co. and the Missouri Valley Bridge & Iron Co., jointly, which began actual work early in 1917 and have just about completed the construction. By December, 1917, the pump well walls had been finished 18 feet high and work was stopped for the winter. In February a flood carried away much of the docking, etc., and work could not be renewed until April, 1918, since when it has been carried on continuously.

The contractors began paying labor 25 cents an hour, advanced this to 30 and then to 40 and 45 cents, but even this did not bring enough men, and the waterworks board decided to allow the contractors such sums as represented the difference between the price of labor and cost of materials then prevailing and those that it would be necessary to pay to expedite the work; this sum being estimated at $10,000. This seemed necessary because of the urgency of having the new pump in service this summer.

After considering four types of foundation——open excavation in a steel sheetpile cofferdam, with wood pile foundation; a wooden pneumatic caisson; a combined wood and concrete open-dredging-well caisson; and an all-concrete open-dredging-well caisson—the last was selected. As to the first, it was estimated that not enough piles relying on friction could be driven within the area



GENERAL VIEW OF NEW PUMPING STATION.
Station No. 2 in the background. Girder bridge to embankment, with steel girders enclosed in concrete with panel effect.

18-INCH SUCTION PIPES. NEW PUMPING STATION.

to support the weight of building and pumps, and the open excavation would endanger the other buildings. A steel sheetpile cofferdam would require about 833 tons of sheet piling and bracing and, assuming a fair salvage price, would alone cost about $50,000. A wooden pneumatic caisson had been used for building station No. 2 and found to be too flexible for an engine foundation and also very expensive, besides which it probably could not be made sufficiently water-tight to permit obtaining a dry pump well. The concrete caisson would be built of materials all of which could be obtained easily in the local markets, it could be constructed on the surface of the ground in the dry directly over the location where it was to be sunk, and the entire structure would be permanent. The difficulty of sinking so large a structure to such a depth and bringing it to its final position perfectly level and without shifting horizontally was realized but did not seem to be insurmountable. (As a matter of fact, the caisson shifted toward the river about 15 inches during sinking, probably on account of the high embankment immediately south of it.)

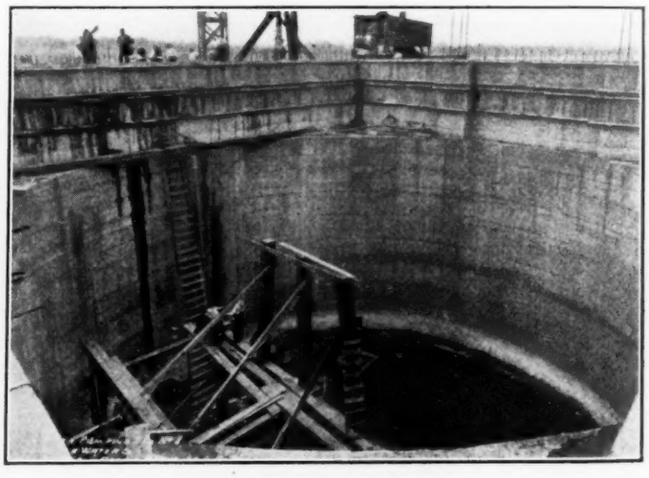
As finally designed, the caisson was 90 feet square and 33 feet deep and contained 16 octagonal dredging wells in the main body and two rectangular wells in the suction-well extension. Provision was made for converting the caisson to a pneumatic caisson if necessary. It was designed to contain 5,858 cubic yards of concrete, 290,000 pounds of reinforcing steel and 159,000 pounds of steel cutting edges, giving it a total weight of 23,193,800 pounds. It was reinforced on all surfaces, both interior and exterior, by one-inch deformed bars, spaced 18 inches between horizontal and about two to three feet between vertical bars. Diagonal bars were introduced between the wells to tie the whole structure together.

Before sinking the caisson, interlocking steel sheet piles were driven on an east and west line south of the new structure and on a north and south line between it and station No. 2, these being for the purpose of preventing any movement of soil under the old station or from the embankment on the south. These piles were driven to a depth of fifty feet below the ground surface, or eight feet below the bottom of the final location of the caisson. The site of the new building was enclosed on the other two sides with an earth puddle cofferdam with wooden sheet piling, carried eleven feet above ordinary level in the river, although twenty-six feet below the highest known flood.

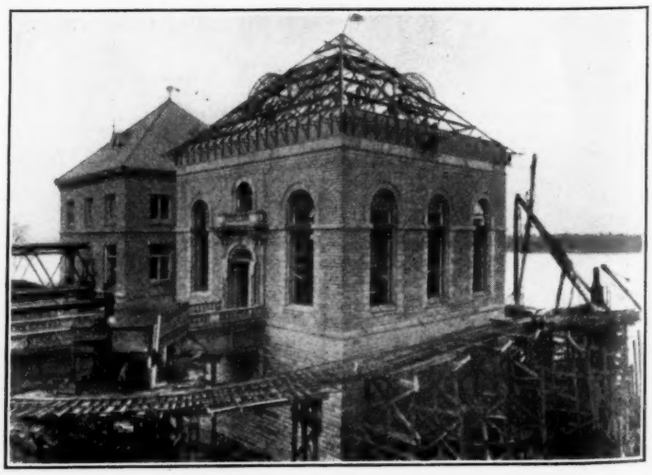
Meantime the contractor had built two trestles for carrying narrow-gauge construction track, one on the east and the other on the west of the building site and meeting in a Y on the embankment on the south, from which point the track ran to a storage yard and railroad siding. Two stiff-leg derricks were placed adjacent to the east trestle, one over the northeast corner of the cofferdam and one just north of the Y, while on the west trestle was placed a revolving crane or "whirley." These derricks were supported on wooden piles at the level of the railway trestles. Their booms were long enough so that their combined sweep covered all parts of the building site. They were equipped with orange-peel and clam shell buckets for excavating under the caisson through the dredging wells.

A concrete mixing plant was constructed near the north-east corner of the cofferdam, with a concrete elevator tower, sand and gravel hoppers and an inclined railway running from the concrete mixer serving platform to a cement storage barge moored in the river. Fifteen or twenty sacks of cement could be brought at a time from the barge to the mixer by means of this railway. The sand and gravel hoppers were loaded by a derrick boat from barges in the river. The tower was 112 feet high and provided with steel trussed chutes by which the concrete could be discharged into any part of the caisson.

After the derricks had been erected, the ground was leveled off to receive the caisson, and underground obstructions such as old piles, sunken trees, etc., were explored for and removed.



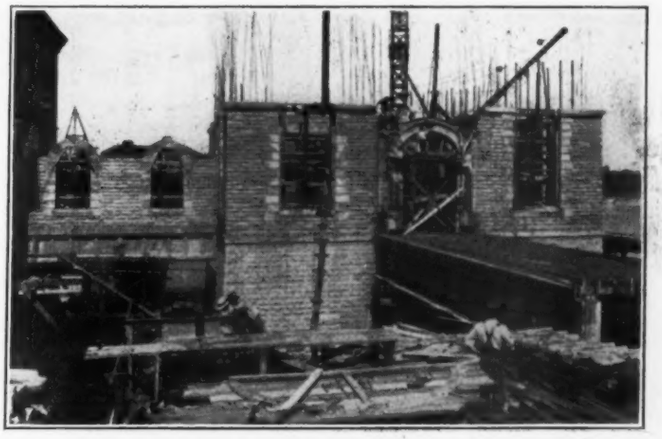
PUMP WELL COMPLETED.
The concrete has reached the main floor level.



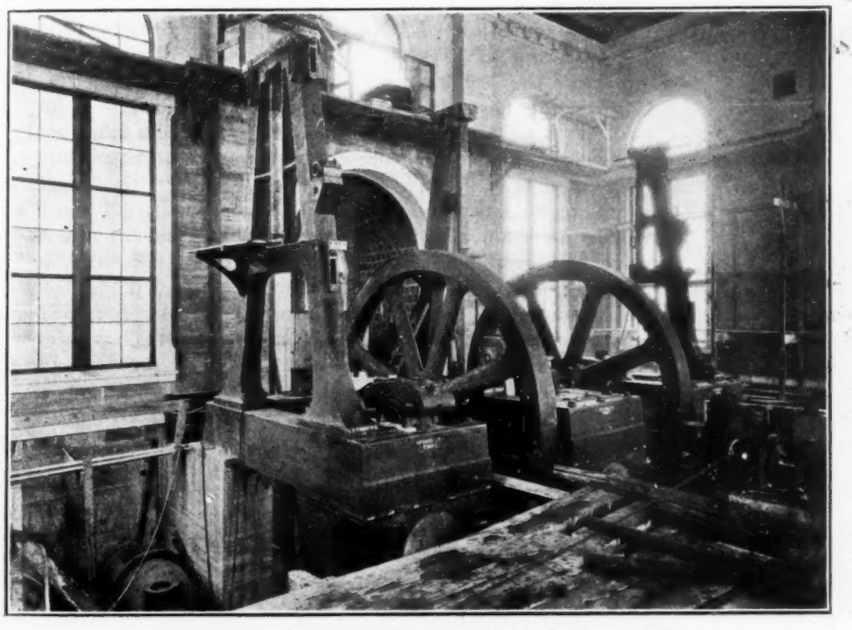
NEW PUMPING STATION NEARING COMPLETION.

The cutting edges of the caisson were put in place and riveted during May, 1917, the wood forms for the concrete sides were carried up about fifteen feet, and the filling of them with concrete began on May 30th, and continued night and day (save for a few minor delays such as breaking down of the mixer engine) until June 6th, when the caisson wall had been brought up to a height of fourteen feet, when it was allowed to stand and harden before sinking the caisson.

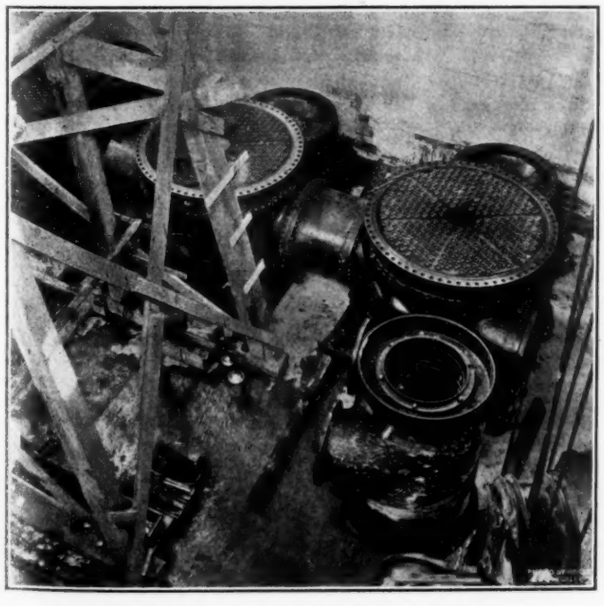
Excavating in the dredging wells was begun on June 15th, using one-yard orange peel and clam shell buckets. The material so excavated was deposited in dump cars having a capacity of four cubic yards which were run on the construction tracks carried by the trestles previously referred to and hauled to a depression about four hundred feet south of the building. The excavated material was mostly fine sand and river mud at the top, growing coarser as the excavation proceeded and finally running clean sand and gravel with small boulders. Later the outside and interior walls were carried higher,



SOUTH ELEVATION OF NEW PUMPING STATION.
Shows passage between new and old stations.



PROGRESS OF PUMP ERECTION ON MAY 1, 1919.

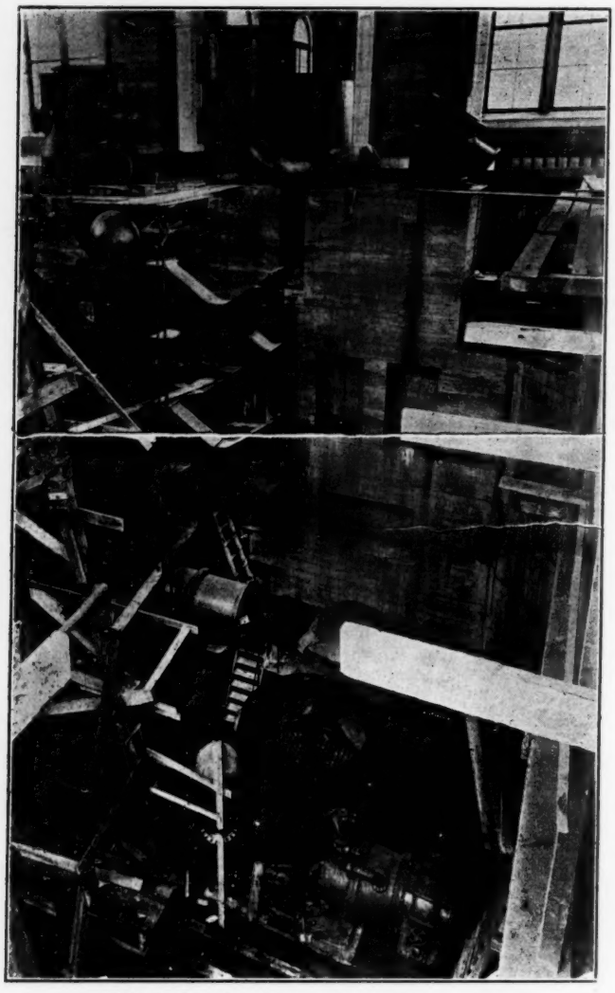


THE THREE FLAT VALVE DECKS IN POSITION.

the caisson meantime being sunk a little at a time, until it had been lowered about thirteen and a half feet. At this time the average elevation of the ground under the middle of the caisson was about ten and a half feet below the outside cutting edges. In order to settle the caisson, the walls were finished to their full height, both outside and interior. Toward the end of the operation, material excavated in the outside wells was deposited in the center wells so as to level up the surface of the ground under the caisson. When the caisson was within three feet of its final position it was jetted down the remaining distance, since the sinking could be controlled better in this way than by bucket excavation. The sinking was stopped three inches above the designated elevation, as it was expected that a slight settlement would take place due to the weight of the structure. The interior dredging wells were filled with dirt up to the under side of all the interior cutting edges, so that each well could be filled with concrete without its flowing to the other wells.

Before the caisson was filled with concrete, water was allowed to rise in the cofferdam until it came to the top of the caisson, so as to balance all forces as much as possible. Concrete was then placed to a depth of six feet in the bottom of each well, being placed under water by use of a tremie. Following this, a second concrete seal four feet thick was deposited. The wells were then pumped out and concreted up to within one foot of the top. The small amount of water leaking up through the concrete was confined to one side and removed with a siphon. When the well had been filled to its proper height, pipes were inserted in the concrete over the leaks and grout forced in under pressure, which effectually sealed the leaks. Following this, a reinforced concrete floor two feet thick was placed over the entire caisson, except the screen-well bay, this work being begun on October 11th, along with constructing the main substructure walls.

The walls of the substructure were constructed by setting four or five courses of stone and then backing up to this height with concrete. Work closed down on November 19th, and was resumed on March 22, 1918. When the substructure had been completed to the eleva-



PROGRESS OF PUMP ERECTION IN APRIL.

tion of the main engine-room floor, the "whirley" was moved from the west trestle into the center of the building, where it was used in erecting the main walls of the station and also the steel roof.

The main house walls were carried up in the same way as the substructure, a few rows of outside stone being laid, forms being placed inside, reinforcing steel put in place, and concrete poured between the facing stone and the forms. Erection of the steel roof trusses was started on November 22nd and completed on December 22nd, and by January 10, 1919, the roof was sufficiently covered with tile to be practically water-tight and temporary heating coils were placed in the building so that the interior work could be carried on during cold weather.

The only accidents or other interference with the regular procedure of the work were a breaking of the concrete mixer engine; the collapsing of the derrick on the northeast corner; the settling of the piles supporting the "whirley," necessitating the driving of longer supplemental piles (the settlement probably being due to the excavation of the material inside the caisson); the breaking of a goose-neck on the southeast derrick and later the breaking of a boom on the same derrick. Considering that this work covered a little more than two years of almost continuous construction, and that these breaks were of minor importance and resulted only in delays of two or three days each, this record seems to be a very good one. The caisson drifted about fifteen inches north during settling, but sufficient allowance had been made in the size to permit locating the building itself on the lines originally intended.

The pumping station is now completed so far as is possible before the work of erecting the pump has been finished, and such erection had, about a month ago, progressed to the point shown in one of the photographs on the previous page. The chief engineer and superintendent, James B. Wilson, hopes to start the pump in operation by the first of July.

DISINFECTION OF WATER SUPPLIES

Opinions of Its Value by Water Works Officials in All Sections of the Country—Used Alone as the Sole Guard Against Typhoid, or in Connection with Filtration as Additional Safeguard.

The most outstanding and important development in municipal water supplies during the last decade has been the rapid and general adoption of disinfection (also called sterilization) accompanied by a perfection of methods. So far, chlorine, in the form of either hypochlorite or liquid chlorine, is the agent used in all but a few municipalities, although other methods are theoretically effective and the practical details for use in service have been worked out, and such use has been initiated.

Concerning the value of the use of chlorine, there seems to be practically but one opinion, expressed with different degrees of enthusiasm, according to the nature of the one giving it or his individual experiences. Many of these opinions will be quoted in this article.

A few weeks ago we wrote to a number of health and water works officials, asking for data concerning the use of disinfectants in their respective cities, and their opinions as to the advantage of such use. The data are best presented in the form of a table, and owing to the considerable amount of tabular matter in this issue, it seems best to defer this to next week's issue.

A number of typical opinions submitted by the officials questioned are given herewith.

NEW ENGLAND.

Rutland, Vt.: "We have had no cases that we could trace to the water supply since use of bleach was begun in 1910. All imported or contact cases, which could be identified as such. We are now using chlorine gas, which we find cheaper and more satisfactory. There is no doubt of the efficacy of the chlorine treatment of water." Dr. Charles A. Gale, President, Board of Health.

New Haven, Conn.: "It is indispensable for the water supply of the city of New Haven."

MIDDLE ATLANTIC.

Yonkers, N. Y.: "It (the use of liquid chlorine) enables us to operate the slow sand filters at a higher rate per acre per day than would be allowable otherwise. This is, of course, true of chlorination in general.

"It is more reliable, (compared with hypochlorite,) because:

(a) It is uniform in strength and practically 100% pure.

(b) It does not lose its strength, as hypochlorite does, both in the solid form and in solution.

(c) There is no residual sludge.

(d) There is no clogging of tubes and orifices.

(e) There are no fumes and dust.

"It requires very small space.

"It is simple, and easy to operate and regulate.

"It requires much less attention than hypochlorite and hence, is cheaper to operate

"It is therefore more positive in its operation and effect."

Trenton, N. J.: "When commission government took hold of the city, late in 1911, we were using the raw Delaware water for drinking purposes, and our typhoid rate was very high, (23 to 35 deaths a year). The new commission immediately started to treat our drinking water with hypochlorite of calcium and made arrangements to build a rapid sand filtration plant. You will note the marked decrease in typhoid since these measures were first started late in 1911. (The deaths fell to 20 in 1912, and 6 in the following years, and 3 to 6 after the filter was in use). We have nothing but what is good to say of the use of chlorine in the water." Dr. A. S. Fell, health officer.

Philadelphia, Pa.: "The use of chlorine as a sterilizing agent is desirable as affording an additional precaution against possible pollution where filters are operated at the high rate demanded of the Philadelphia plants. Liquid chlorine is preferable over hypochlorite of lime for the following reasons:

"1.—Economy of space for storing chemical containers.

"2.—Economy of space for apparatus applying sterilizer.

"3.—Economy of installation.

"4.—Economy of maintenance charges."—C. E. Davis, chief of Bureau of Water.

SOUTH ATLANTIC.

Baltimore, Md.: "The evidence available points to use of chlorine in the water supply from 1911 to 1915 as playing an important part in the reduction of the typhoid fever rate. Since 1915, when the filtration plant came into use, post-filtration chlorinization of the water has probably been of protective value at all times, and of positive protective value at certain times."—W. T. Howard, assistant commissioner of health. The writer calls attention to the undoubted influence of the new sewerage system in Baltimore, control of milk, reduction of flies and decrease of typhoid in rural Maryland in lowering the typhoid rate in that city. (Reducing typhoid in Maryland is described in an article in this issue.)

Talladega, Ala.: "During November and December, 1916, the chlorinating plant was not in operation, and the number of cases of typhoid fever and dysentery immediately increased." —W. E. Burt, city and county health officer.

CENTRAL STATES.

Grand Rapids, Mich.: "It is questionable whether we could meet the U. S. Treasury standard of bacterial removal and colon content at all, without its use, or only at the expenditure of much larger quantities of alum than are now required. (The water is filtered as well as chlorinated.) We consider it absolutely indispensible to the safety of the small supply, where more extensive treatment is not desirable or possible." —Walter A. Sperry, chemist of filtration plant.

Cincinnati, O.: "The cost of disinfection with liquid chlorine was only 15 cents per million gallons in 1918. We consider the use of chlorine as an added precaution to insure the safety of a drinking water. Its use, in our case, had another advantage—it prevents the growth of miscroscopic plant and animal life in our clear-water reservoir during summer.

"Our laboratory data show that our unsterilized filtered water, although of very low and satisfactory bacterial content, has 78% of its total number of bacteria, and 71% its colon bacilli removed by chlorination."—C. Bahlman, chief bacteriologist.

Terre Haute, Ind.: "We favor the use of chlorine more in our case as a precautionary measure, although it permits a reduction in the use of coagulant, and at the same time insures a more uniform supply."—W. H. Durlin, assistant manager.

Quite a number—possibly a third—of the health officials report that few, if any, cases of typhoid in their cities are derived from the water supply, or were so derived before the use of chlorine was begun; but the chlorine is employed as a safeguard against possible contamination of the water, such application being easily and inexpensively made.

The value of chlorination as permitting a reduction in the amount of coagulant in the filtration process is referred to by several. Such reduction effects an economy which will partially, if not wholly, offset the cost of applying the chlorine. It would seem, however, that this would be possible only where the amount of coagulant is regulated by the reduction in bacteria, rather than by that in suspended matter.

CHLORINATION IN MICHIGAN.

Applied to Ninety Per Cent. of the Water of Public Supplies — Comments by State Sanitary Engineer on Its Uses and Effects.

Thirty-six Michigan municipalities treat their public water supplies with chlorine, either as liquid chlorine or as hypochlorite. Beginning with January 1st, 1916, monthly reports covering the daily operation of each plant for the previous month have been required by the State Board of Health. Through the courtesy of Edward D. Rich, state sanitary engineer of Michigan, we have received information concerning these supplies, which is presented briefly in the following paragraphs:

Adrian: Population, 11,662. Liquid chlorine since March, 1916. A more or less out-of-date and crude form of filtration has been maintained by the local water company since 1898. Subsequent to 1916, more careful attention has been given to its operation, and some improvements have been made. Chlorination has been used as an adjunct since March, 1916.

Alpena: Population, 13,480. Hypo. in February, 1913; liquid chlorine since October, 1915. This source of supply comes from Thunder Bay. Water receives the untreated sewage of the entire city, and is of quite shallow depth. Considerable trouble has been experienced from turbidity, and the water has a high organic content. Hypo-chlorite treatment was used from 1913 to 1915, with very poor results, because it was not given proper supervision, but since 1915 the results have been better, probably due more to careful supervision than to a change to liquid chlorine. Objectionable tastes have always been present on account of high organic content, and the large proportion of wooden mains. An improved water supply for Alpena is under consideration. Filtration has been recommended.

Ann Arbor: Population, 15,072. Hypo. in 1912; liquid chlorine since June 15, 1915. Part of the supply is taken from wells, and the remainder from the Huron river, the river portion being chlorinated. On account of high organic content and indifferent attention, the results have been disappointing. Objectionable tastes have probably played some part in the lack of efficiency. Wells are being developed which will eliminate the necessity of using river water.

Battle Creek: Population, 30,900. Hypo. in 1912; liquid chlorine since April, 1914. Most of the supply comes from deep wells and is used untreated. During the summer when the demand is high, some water is pumped from Goguac lake, near the city limits, which is used to a great extent as a summer resort and also carries a very high organic content. We have reason to believe that chlorination has been successful in this instance.

Bay City: Population, 48,835. Liquid chlorine since April, 1919. The supply is taken from two points in Saginaw Bay, and one point in Saginaw river, and is too highly polluted to be rendered safe by chlorination without excessively disagreeable tastes. The bay receives the sewage from Saginaw and Bay City. A severe epidemic of typhoid prevailed in 1916, which resulted in the installation of a chlorine apparatus. Filtration is under consideration. The city water supply is not supposed to be used very extensively for drinking purposes.

Cadillac: Population, 10,351. Liquid chlorine since January, 1919. This supply is taken from a small lake on the edge of town, which receives storm water from the streets, but no sanitary sewage, and carries a high organic content. Tests covering a number of years have shown the presence of B. Coli almost constantly, but we believe that this supply has been safer than most waters giving the same analytical results, because of the nature of the contamination. A number of private wells are in use, and I hardly think it fair to charge the entire typhoid record to the city water supply. Chlorination has just been provided for.

Detroit: Population, 900,000. Chlorination of the Detroit supply receives most careful attention at the hands of the local authorities and we believe is of maximum efficiency. Filtration is under consideration.

Escanaba: Population, 16,525. Hypo. since September, 1914. This supply is taken from Little Bay de Noc, an arm of Green Bay, which is polluted by the sewage of Escanaba and Gladstone. The typhoid rate was exceedingly high until filtration was installed in 1909, which immediately cut down the figures to a more reasonable amount. Hypochlorite has been used as an adjunct to filtration since 1914. I do not believe that it is fair to charge all of the typhoid cases since

1909 to the city water supply, for private wells are quite extensively used, and there is a good chance for imported cases, Escanaba having the only hospital facilities available for a large portion of the upper peninsula.

Flint: Population, 60,000. Liquid chlorine since January, 1916. The water supply is taken from a river which is very heavily polluted above the city. The filtration plant was built in 1912 and 1913, and chlorination has been used as an adjunct since January, 1916. The high rate for 1916 is probably quite largely due to a severe milk epidemic in the early months of that year. It is quite possible that the high rate for 1917 might be due to some similar cause, or it may appear in a false light on account of the rapidly increasing population of the city, which we are unable to determine accurately. The growth of Flint has been most remarkable. The population in 1900 was about 13,000. The automobile industry started to boom in 1905 and 1906, and a population of about 24,000 is recorded in 1906. In 1910 the census shows 38,550. This rate projected ahead to 1918 gives an estimated population of 60,000, and 90,000 is claimed. It has been impossible for the municipality to keep pace in sanitary matters with its rapid growth, but I believe it can be safely said that filtration and chlorination have done valuable work.

Gladstone: Population 5,123. Hypo. since December, 1913. The supply is taken from Little Bay de Noc and is subject to pollution from the sewage of the city. Chlorination seems to have been effective.

Grand Rapids: Population 150,000. Hypo. in January, 1913; liquid chlorine since February, 1918. The advent of filtration and sterilization on January 1, 1913, has produced very satisfactory results.

Hillsdale: Population, 5,257. Liquid chlorine since September, 1917. This supply is taken from a small lake which is subject to summer pollution from campers, and winter pollution from ice cutting operations. Chlorination has been installed as a precautionary measure.

Highland Park: Population 40,000. Liquid chlorine since June, 1915. This municipality is within the limits of the city of Detroit, although it has its separate government. Its water comes from Lake St. Clair, which is always subject to some pollution, and to considerable turbidity. Chlorination seems to have been effective, although it has not been supervised as carefully as is possible. The construction of filters is under way.

Ironwood: Population, 14,821. Hypo since November, 1917. The supply is taken from a river which is subject to some rural contamination, and carries a high degree of color and some turbidity. The filter plant installed in 1914 was never of adequate size, and chlorination was adopted as an assistance to the filtration process. This is a mining district and it is doubtful if all the typhoid should be charged to the water. A new filter plant is under consideration.

Ludington; Population 11,334. Hypo. since 1912. The supply is taken from Lake Michigan and is subject to sewage pollution from the city. A broken intake in 1912, and possibly in 1911, added to the chance for contamination of the water. The record of Ludington is one of the best instances of the efficiency of chlorination alone.

Manistique; Population 4,890. Liquid chlorine since October, 1918. Manistique is a small place and the occurrence of a death or two a year has a very marked effect on the curve. This is not regarded as a particularly dangerous supply, but chlorination has been used as a precautionary measure.

Marine City; Population 3,778. Hypo in December, 1913; liquid chlorine since October, 1918. This supply comes from the St. Clair river, which is contaminated by the sewage from St. Clair and Port Huron. Hypochlorite has been used since December, 1913, with exceedingly poor supervision, if any at all. Liquid chlorine with laboratory control has recently been installed and we are hopeful of better results in the future.

Marquette; Population 12,681. Hypo July, 1911 to December, 1913; March, 1915, to June, 1915; January to May 1916; since November, 1916. Liquid chlorine since March, 1917. The city maintains a laboratory and chlorination is used whenever the results of analyses indicate its necessity. The intake extends about 3,000 feet into Lake Superior into 70 feet of water. The extension of the intake some years ago probably resulted in improved conditions. High rates for 1910, 1911 and 1912 are not explained. A broken intake discovered in about 1908 or 1909 was doubtless responsible for high figures at that time.

Menominee; Population 8,586. Hypo in March, 1910; liquid chlorine since October, 1916. The supply is taken from Green Bay, which is subject to sewage contamination from Menominee and Marinette, Wis. The use of hypochlorite seems to have been responsible for a material reduction in the typhoid rate.

Monroe; Population 7,928. Hypo in August, 1915; liquid chlorine since October, 1915. The supply is taken from the western end of Lake Erie and is subject to sewage contamination from Monroe and possibly from the Detroit river. Quite a serious epidemic occurred in 1915 due to sewage pollution of wells and of the city supply. The use of chlorination seems to have had some effect, but this supply can never be properly treated except by filtration.

Munising; Population 4,180. Hypo October, 1913, to November, 1915; liquid chlorine since November, 1917. The water supply was formerly taken from a shallow depth in a small bay, which received municipal sewage, but was extended two or three years ago to Lake Superior at a point where it is likely to be polluted by sewage passing out of the bay. Chlorination has not received proper supervision and its results have been unsatisfactory.

Negaunee: Population 11,677. Hypo in January, 1914; liquid chlorine since October, 1917. The supply is taken from a small lake on the edge of town which is subject to pollution from miners' homes in the vicinity. Chlorination seems to have been effective. The high rate in 1917 was due to an epidemic traced to ice cream.

Niles; Population 5,843. Liquid chlorine since January, 1918. Chlorination has been in use too short a time to admit of any conclusions.

Petoskey; Population 4,250. Liquid chlorine since August, 1918. Chlorination has been in use too short a time to admit of any conclusions.

Port Huron; Population 18,618. Hypo in June, 1912; liquid chlorine since June, 1914. A severe epidemic at Port Huron in 1912 resulted in the installation of hypochlorite treatment, with good results. It has not received as perfect attention as we hope it will in the future.

St. Clair: Population, 2,633. Hypo. in May, 1913; liquid chlorine since November, 1917. The supply is taken from the St. Clair river, which receives the sewage from Port Huron. Chlorination has been a remarkable success in this case.

St. Joseph: Population, 6,759. Hypo. in July, 1912; liquid chlorine since November, 1917. The supply is taken from Lake Michigan and is subject to sewage pollution from St. Joseph river. Chlorination seems to have been effective.

Sault Ste. Marie: Population, 14,339. Liquid chlorine since June, 1918. Chlorination was installed so recently as to make conclusions impracticable.

South Haven: Population, 3,317. Hypo. since April, 1912. The supply is taken from Lake Michigan and is subject to sewage contamination. The city does a large summer resort business, and it is quite possible that the higher rates in 1914 and 1916 were due to imported cases.

Traverse City: Population, 14,346. Hypo. in February, 1913; liquid chlorine since May, 1916. The supply is taken from Little Traverse Bay, which is subject to sewage pollution. I do not believe that the increase in rates for 1916 and 1917 is entirely chargeable to city water.

Trenton: Population, 1,256. Liquid chlorine since January, 1918. The supply is taken from the highly polluted Detroit river, and until January, 1918, was used without treatment. The low rates in 1905, 1910, 1912, and 1914 were probably due to the immunity developed in the inhabitants by the constant drinking of diluted sewage.

Wyandotte: Population, 12,103. Hypo. since April, 1914. The supply is taken from the highly polluted Detroit river, and its purification has been attempted by means of chlorination, without success for the reason that such disagreeable tastes and odors are caused. An extension of the intake and a filter plant are now under construction. Investigation of typhoid fever cases in 1916 showed that many of the patients were people who had recently moved to Wyandotte.

Further data concerning the Michigan cities will be given next week, showing the effect of the sterilizing treatment. With this will be given also data concerning the results of operation in other cities.

For keeping in touch with the operation of these plants, the state board requires each plant to send to it, once a month, a daily record of the amount pumped, amount of chemical applied, turbidity and oxygen consumption of raw water; the 20 degree and 37 degree count of bacteria in raw and treated water, and the results of tests of both raw and treated water for gas formers. It is also made obligatory that the board be notified immediately in case the flow of sterilizing agent is discontinued for more than twenty-four hours.

PROGRESS OF WATER DISINFECTION IN MARYLAND.*

Need Shown by Survey by State Health Department —General Description of Plants and of Results of Chlorination.

By ROBERT B. MORSE and HARRY R. HALL.†

There are eighty-two public water supplies in Maryland, serving about 862,489 people—62.2 per cent of the estimated total population of 1,384,539. Several community systems delivering water to small groups of houses, and also institutional supplies, are not included in this number.

The state, through its Board of Health, has had, since 1914, supervisory control over the design, construction, and operation of water systems. No material extensions of, nor alterations in, existing systems can be legally made, nor can new supplies be installed, unless complete plans and specifications covering the proposed work are submitted to the State Board of Health for approval and a written permit is granted by that body. Moreover, when deemed necessary for the public health or welfare, the Board may require existing water systems extended or altered, and it is empowered to compel the installation of public supplies in communities not served. It is the duty of the corporate officers to raise the funds necessary for carrying out the work required, and they may do this, if they wish, by issuing bonds without special legislative enactment and without a referendum vote.

Broad as is the control of the state over the design and construction of water supplies, it is no more liberal than is its authority over the operation of existing systems, in so far as the public health is affected. If the State Board of Health finds that any water plant is not properly operated, it may require a change of method, and may, when necessary, force the employment of competent attendants, it even being enabled to attain this end by appointing attendants of its own selection, at the cost of the municipality or water company owning the plant. Possible arbitrary action, however, is precluded by a provision in the law allowing appeal to the local county court, before which the Board would have to prove the reasonableness of its act.

The engineering division of the State Board of Health was organized in June, 1912, under a law passed in 1910. The early engineering studies indicated plainly the need of the complete supervisory power over the water supplies of the state, and this need was satisfied by the passage of the water supply and sewerage act of 1914. In 1912, when the engineering investigations were begun, it was found that, in general, knowledge of the condition of the public water supplies in the state was meager. Analyses of the water from many of the supplies had been made occasionally, but no systematic method of examination had been followed.

The state's investigations commenced to show that many of the water systems were badly in need of attention. The surface supplies were derived from streams fed by watersheds containing habitations, in many cases providing numerous sources of contamination, and, in general, protection was not offered by long storage, filtration, or other treatment. Water was usually taken from the stream at an intake dam, and passed into a distributing reservoir of insufficient capacity to provide a safe period of storage. Moreover, water from some of the tubular well systems was found to be polluted, because the wells either were too shallow and located in the midst of thickly settled districts where sources of pollution were numerous, or were driven in rock containing fissures. Some supplies previously considered to be beyond suspicion were found, upon close investigation, to be in a bad condition and a menace to the public health.

In a number of instances where supplies were polluted, the water was satisfactory from a physical standpoint, there being an absence of color, turbidity, and other objectionable characteristics. This was naturally true in the case of most well and spring waters. The water from streams fed by mountain watersheds, and from watersheds containing much wooded or uncultivated land, was also generally in good physical condition.

Where water, otherwise acceptable, was found to be in an unsafe sanitary condition, filtration did not appear to be necessary or even generally advisable for assuring the proper degree of purity. Expense and the improbability of proper operation are two factors which would make filtration plants undesirable for many of the small systems which abound in Maryland. Consequently, disinfection was resorted to wherever it would serve the purpose. There were, however, a considerable number of surface supplies derived from streams flowing through cultivated country and furnishing a water occasionally or persistently turbid. Such supplies as these naturally require filtration. Disinfection in connection with filtration is general and is required in most new installations. While the writers' assistants have been able to obtain good results from several filter plants without the addition of disinfectants, the character of attention which small works ordinarily receive makes their use essential.

Prior to 1912, there were only four disinfecting plants in operation on water supplies in Maryland. Two of these were located on the Gunpowder river and Jones Falls systems, of Baltimore; and two, owned by the Baltimore County Water and Electric Company, were at the Avalon and Herring Run plants, which serve large sections in Baltimore County near the city. At Avalon, disinfection was carried on in conjunction with filtration. All these installations used hypochlorite of calcium, and at Herring Run ozone was employed at times.

Since 1912, many towns in other parts of Maryland have been provided with purification plants, and it is a striking fact that, of the 862,489 persons served by public water supplies at the present time, 785,000 or 91.1 per cent (approximately 56.7 per cent of the population of the state) use water which is treated by either filtration or disinfection, or both.

Fifty-nine of the eighty-two public water supplies derive their water from underground sources. The population thus served amounts to 102,942. The number of consumers is small in comparison with the number of systems, because these supplies, in general, are located in the smaller towns. The remaining twenty-three systems take water from surface streams and serve a population of 759,547. The large population using surface water is accounted for by the fact that Baltimore and most of the other places of considerable size are thus supplied. Ground waters are used by 12.0 per cent of the people served by public systems, and by 7.5 per cent of the total population of the state. The corresponding figures for surface waters are 88.3 and 54.6 per cent.

Not only is the influence of water purification felt by the public water supplies but it has reached to state and private institutions as well. There are eight institutions, embracing a population of 4,855, where the water receives treatment of some kind, and in all but two of these it is disinfected.

*Slightly condensed from a paper presented before the New England Water Works Association, which has since been modified by the authors to bring it up to date.

†Chief engineer and assistant chief engineer, respectively, of the Maryland Department of Health.

Disinfection by means of hypochloride of calcium or liquid chlorine is naturally the most common method practiced, although there is one ozone plant which is operated in conjunction with one of the hypochlorite installations. One ultra-violet ray disinfection apparatus has already been installed and another will soon be completed. Both are to be used in conjunction with filtration.

The type of apparatus suitable for hypochlorite or liquid chlorine treatment in any particular case depends upon the method by which water is supplied. Where the flow of water to be treated is at most times substantially uniform, as in the case of certain pumping plants, or in gravity lines discharging into reservoirs, a manually controlled apparatus is sufficient. Where fluctuations occur in the rate of flow, automatic control devices are essential for proper results. Liquid chlorine plants, so-called, introduce chlorine into the water either as a gas or in solution. The gas feed, usually called "direct feed," is well adapted for use where no water under pressure, for dissolving the gas, can be obtained easily. There is one direct-feed plant in Maryland at the present time; and only one, at Perryville, is regulated automatically.

The early disinfecting plants, as stated previously, all made use of hypochlorite of calcium, and with effective results. Those on the Avalon and Herring Run supplies of the Baltimore County Water and Electric Company were the first to be installed in the state. The former was constructed in 1908, and the latter during the year following. Late in 1910 the Jones Falls supply for Baltimore was first disinfected, and in June, 1911, the Gunpowder River plant was put into use. Until 1913 these were the only installations of disinfecting apparatus used for water purification in Maryland. A filtration plant had been previously built by the Washington County Water Company, to supply Hagerstown from Antietam creek during dry periods, and hypochlorite dosing apparatus had been provided; but the disinfectant was not used until the summer of 1913. About the same time, the State Board of Health constructed a plant for the Ellicott City system. Cumberland next followed, during the fall of the same year, by putting into operation a hypochlorite plant in conjunction with the mechanical filters on its new supply. In December, the mountain supply of Hagerstown was furnished with hypochlorite apparatus. A typhoid fever epidemic at Rockville during February, 1914, made necessary the construction of an emergency hypochlorite plant by the State Board of Health, for treating the supply derived from tubular wells driven in rock and proven to be the cause of the disease. The first liquid chlorine apparatus was put into operation at Union Bridge in January, 1914, for treating about 120,000 gal. of water derived from tubular wells driven in limestone rock. An ozone plant had been installed in 1909 at the Herring Run supply of the Baltimore County Water and Electric Company, but at first it was used, so the writers are informed, only experimentally.

After the powers of the State Board of Health were broadened in 1914 and an increased appropriation was provided for sanitary engineering work, water purification plants naturally were introduced at a more rapid rate than previously.

Data concerning the disinfecting plants now in use in Maryland are shown in the accompanying table. In addition to the plants shown in this table, there are in operation several water supply systems on federal reservations in the state, which are not included in our discussions or tabulations concerning public water supply systems. These are located at the following stations: Perry Point, Camp Meade, Curtis Bay Ordnance Depot, Camp Holabird, Aberdeen Proving Ground, and Edgewood Arsenal.

Changes are taking place continually in the water supply situation in this state, and it is expected that the number of disinfecting plants soon will be increased and that alterations will be made in some of the water supplies, which will involve plants now in operation.

DATA CONCERNING WATER SUPPLY DISINFECTING PLANTS IN MARYLAND.

Place	Population (Estimated 1918)	Type of Plant	Character of Supply	Date	Average Amount Treated Daily (Gallons)	Chlorine Parts Per Million	Where Chemical is Applied	Character of Attention
Plants for Disinfection Only.								
Annapolis	8,677	Liquid Chlorine	Surface	1915	1,400,000	0.30	Pump suction	Fair
Arlington	10,000	Liquid Chlorine	Ground	1914	112,000‡	0.30	Pump suction	Good
Braddock Heights	175	Hypochlorite	Ground	1918	10,000	0.30	Pump suction	Good
Elkton	2,442	Hypochlorite	Surface	1917	250,000	0.50	Pump suction	Poor
Frederick	11,340	Liquid Chlorine	Surface	1915	1,600,000	0.35	Supply main	Good
Frostburg *	6,655	Hypochlorite	Ground	1916	300,000	0.30	Pump suction	Indifferent
Glen Echo	240	Hypochlorite	Surface	1918	20,000	0.5-1.0	Supply main	Good
Hagerstown	27,000	Hypochlorite †	Surface	1913	3,600,000	0.60	Supply main	Good
		Liquid Chlorine	.....	1914	.....	....	.....	.....
Herring Run	28,000	Hypochlorite	Surface	1909	3,000,000	0.40	Pump well	Good
		Ozone						
Kensington	865	Liquid Chlorine	Ground	1918	50,000	0.30	Pump suction	Good
Maryland Tuberculosis Sanatorium	600	Hypochlorite	Ground	1915	60,000	0.60	Pump suction	Good
Princess Anne	1,133	Hypochlorite	Ground	1917	100,000	0.18	Pump suction	Good
Rockville	1,239	Liquid Chlorine	Ground	1916	30,000	0.20	Collecting res.	Good
Salisbury	8,696	Hypochlorite	Ground	1917	300,000	0.25	Pump suction	Good
Union Bridge	918	Liquid Chlorine	Ground	1914	120,000	0.30	Pump suction	Good
Westernport	3,288	Hypochlorite	Surface	1914	450,000	0.40	Supply main	Poor
Plants for Filtration and Disinfection.								
Avalon	32,000	Hypochlorite	Surface	1908	2,000,000	0.40	Outlet Coag. Basin	Good
Baltimore	599,650	Hypochlorite	.....	1915	110,000,000	0.30	Filtered water	Good
		Liquid Chlorine						
Cumberland	26,074	Liquid Chlorine	Surface	1913	8,000,000	0.50	Inlet Coag Basin	Good
Hagerstown	27,000	Hypochlorite	Surface	1913	3,600,000	0.60	Filtered water	Good
		Liquid Chlorine						
Laurel	2,692	Hypochlorite	Surface	1915	150,000	0.25	Filtered water	Good
Luke	950	Liquid Chlorine	Surface	1918	160,000	0.50	Filtered water	Good
Maryland House of Correction	700	R. U. V.	Surface	1918	250,000	....	Filtered water	....
Notre Dame	353	Liquid chlorine	Ground	1915	30,000	0.25	Pump suction	Good
Springfield State Hospital	1,800	Liquid Chlorine	Surface	1918	330,000	0.30	Filtered water	Good
Takoma Park	1,646	Liquid Chlorine	Surface	1918	200,000	0.30	Filtered water	Indifferent
Westminster	3,374	R. U. V.	Surface	1918	400,000	....	Filtered water	Good

*Used during dry weather periods only—emergency supply. †Now kept for emergency use. ‡Mixed with about 231,000 gallons untreated water.

The amount of chemical used at the disinfecting plants in Maryland has varied widely according to local conditions. It has ranged from 0.2 to 3.0 parts per million of available chlorine. Where the disinfectant is applied to a spring or well water, or to the effluent from a well-operated filtration plant, the amount required is usually near the minimum mentioned above. In the case of turbid waters, large amounts have been found necessary for proper treatment, and at times of extreme turbidity even excessive quantities are inefficient. In the treatment of the Baltimore City water, as high as 3 parts per million of available chlorine, of 75 pounds of hypochlorite to the million gallons, have been used on raw water. The amount necessary in many instances depends also upon the character of attention given the apparatus.

It is by no means a fact that the disinfecting plants in Maryland have been operated with complete satisfaction, for most of them have had trouble of some kind. The difficulties encountered could generally have been avoided with more attention to proper operation. With hypochlorite plants, the principal annoyance has been due to the formation of coatings which clog the pipes; and, where the solution was particularly strong, the materials of which the piping was made have been attacked, necessitating the replacement of parts. These are not serious troubles, however, and can be eliminated by frequent inspection. In the case of liquid chlorine plants, it has been found that occasionally a part becomes corroded and requires replacement, or a valve gets out of adjustment, but the gradual perfection of apparatus is making such occurrences less frequent.

Where faithful and intelligent attention has been given to operation, and the amount of disinfectant used has not been excessive, few complaints have been made regarding tastes or odors in the water. In one instance, where a liquid chlorine plant of the manual control type was disinfecting water the flow of which fluctuated considerably, there was always an overdose at night which caused complaint due to tastes noticeable during the early hours of the day. This, of course, was the fault of the method employed and not of the treatment itself. In general, fewer complaints have been registered concerning disagreeable tastes where liquid chlorine was used than in the case of hypochlorite.

There has been a marked decrease in the prevalence of typhoid fever in some of the communities where disinfecting plants have been installed. In most cases, however, the period of operation has been so short, and, on account of the small size of some of the places, the appearance of typhoid so irregular, that records do not indicate clearly the effect produced. Moreover, much of the typhoid fever in Maryland is attributable to causes other than impure water supplies. Nevertheless, there are certain well-defined instances where a decrease in typhoid fever morbidity and mortality can be traced directly to purification of a water supply. In Baltimore, the reduction has been very pronounced. After the disinfecting plants were built, the prevaalnce of typhoid immediately fell off, and the improvement has since continued. In 1915, both the morbidity and mortality rates from this disease, although higher than in many of the larger cities of the country, were approximately half as great as in 1910. Following the introduction into Cumberland of filtered and disinfected water from Evitts creek, in place of the former raw supply from the Potomac river, the occurrence of typhoid fever was so reduced that in 1915 there were scarcely more than one-sixth as many cases of, and one fifth as many deaths from, this disease as in 1913, in spite of the fact that the corporate limits had been enlarged in the meantime. One of the most striking instances of the effect upon typhoid occurrence caused by disinfecting a water supply in Maryland was that of the Rockville epidemic, which, after twenty-eight cases had occurred, was checked suddenly by the installation of an emergency hypochlorite plant.

In order that prompt remedial measures may be instituted when a water supply is at any time found to be in an unsafe condition, or when an outbreak of typhoid fever casts suspicion on a water previously untreated, the engineers of the State Board of Health are all instructed in the setting up of an emergency hypochlorite dosing apparatus, making use of ordinary and easily obtainable materials. A sketch showing the general arrangement of the device used, including a bill of material, has been prepared, and is usually sent ahead, so that the necessary material may be on hand when the engineer arrives at his destination. This apparatus has proven its value on many occasions and several of the installations are still in operation.

Basing judgment on experience in Maryland, it may be stated that, where chlorinating plants for water supplies are given faithful and intelligent attention, their use is a success; and they provide an effective and inexpensive method for treating many water supplies which do not need filtration, as well as for safeguarding in a measure those supplies for which filtration, although desirable, is prohibitive. Unfortunately, there seems to have been some tendency among manufacturers to convey the impression that little attention need be paid to the operation of a liquid chlorine plant. This has given the operator the impression, in some instances, that the apparatus can be entirely neglected. While it is true that little or no difficulty need be experienced, except when parts give out, neglect is certain to cause irregularity in dosing, exposure in certain cases to freezing and other undesirable results. Greater efficiency from some of the disinfecting plants in Maryland is to be expected in the future, as the State Board of Health will be enabled to make more frequent inspections than in the past. This will be made possible by the fact that, in addition to the main office of the engineering division, there are maintained four offices in various parts of the state, at each of which there is a resident engineer who has direct supervision over sanitary engineering matters in his district. Without an effective system of control, disinfection would fall short of giving satisfaction in connection with many small water supplies.

WATER METER DATA.

Information Furnished by Nearly Four Hundred Waterworks Superintendents—Location, Reading, Testing and Maintaining of Meters —Cost of Meter Service.

On the following pages will be found tabulated a part of the information collected by us by means of a questionnaire, which information was furnished by nearly four hundred and fifty water works superintendents. A third table, dealing with rates, we can not find room for this week, but will give in a later issue.

The questions to which these figures were given in reply were as follows:

"How many meters have you in use?" "How many are under 1 inch?" "How often is each meter read?" "Are all consumers billed at the same time, or in rotation by districts?" "What is the average number of meters read per man per hour?" "Are meters located inside the buildings or outside?" "What is the cost of meter reading and clerical work connected with meters?" "What is the cost of repairs and maintenance per meter in service?" "To what extent are repairs made by the waterworks employes?"

(Continued on page 414)

METERS.

City and State—	Number in use	Number under 1 inch	Frequency of reading each meter.	Billing simultaneous or in rotation.	Average number of meters read per hour per man.	Meters in building or outside.	Cost of meter reading and clerical work on meter accounts.
Alabama:							
Gadsden	2,030	1,800	Monthly	Simultaneous	60	Outside	$175 per month
Talladega	630	618	Quarterly	Simultaneous	*15	Most outside	6.4c.
Arizona:							
Bisbee	None	....	.....	.....	....	....	.....
Clifton	34	22	Monthly	.....	....	Outside	.....
California:							
Alhambra	2,100	1,870	Monthly	Simultaneous	29	Outside	$2.316 per meter per annum
Anaheim	1,252	1,225	Monthly	Same time	40 light, heat and power	Outside	6c. per meter
Lodi	5	1	Monthly	Simultaneous	....	At curb	.....
Los Angeles	99,600	95%	Monthly	Rotation	50	Outside	11c., incl. collections
Oxnard	6	1	Monthly	Simultaneous	....	Outside	Negligible
Palo Alto	1,507	1,469	Monthly	Simultaneous	About 60	Outside	$1,800 per year
Riverside	598	551	Monthly	Simultaneous	.....	Both	.....
Sacramento	None	....	.....	.....	....	....	.....
San Diego	15,169	14,342	Monthly	By districts	41	Outside	$240 per month
Santa Maria	550	510	Monthly	Simultaneous	20	Outside	$32 per month
Stockton	1,600	1,200	Twice a month	Simultaneous	40	At curb, but scattered	.....
Pasadena	12,547	11,436	Monthly	Rotation	38	Outside	$17,454.53 per year
Whittier	1,951	....	Quarterly	Simultaneous	18 to 20	Generally outside	.....
Colorado:							
Colorado Springs	273	167	Monthly	Simultaneous	....	Both	$20 per month
Ft. Morgan	15	10	Monthly	Simultaneous	.....	Inside	.....
Greeley	249	221	Monthly	Simultaneous	12 to 15	Both	.....
Rocky Ford	720	705	Monthly	Simultaneous	20	....	.....
District of Columbia:							
Washington	61,107	57,289	Large consumers monthly or quarterly, others 3 to 6 times a year.	Rotation	22	Outside	28c. per meter
Connecticut:							
Ansonia	665	595	Quarterly	Simultaneous	12	Mainly inside	.....
Derby	262	232	Monthly	Simultaneous	....	Inside	.....
East Hartford	60	20	Every 6 months	Simultaneous	.....	Inside	.....
Hartford	15,451	13,303	Monthly	Simultaneous, twice a year	12	Inside	$19,000 a year
Middletown	2,300	1,600	Monthly	Simultaneous	11	Mostly inside	54c. per meter per year
Putnam	90	About 4/5	Mostly quarterly	Simultaneous	All in less than one day	A few outside	Small
Southington	132	About 112	Quarterly	Simultaneous	8	Mostly inside	.....
South Manchester	1,925	1,784	Quarterly	Quarterly	12 to 15	100 outside	.....
Suffield	316	300	Quarterly	Simultaneous	.....	Mostly inside	.....
Wallingford	318	280	Large meters every 2 months, small meters every 6 months	.....	*75	Inside and in manholes	.....
Willimantic	1,470	1,400	Quarterly	Simultaneous	15 to 20	Inside	.....
Winsted	260	207	Semi-annually	Simultaneous	15	Inside	$25 per year
Florida:							
De Land	925	900	Quarterly	Simultaneous	25	Outside	$40
Fort Myers	183	180	Monthly	Simultaneous	183 in 1 day	Outside	.....
Miami	4,500	4,260	Quarterly	Simultaneous	60	Outside	.....
Ocala	About 800	750	Quarterly	Simultaneous	10	Outside	$15 per week
St. Augustine	500	450	Quarterly	Simultaneous	12	Outside	$12
St. Petersburg	2,581	2,560	Monthly	Simultaneous	About 40	Outside	$125 per month
Georgia:							
Albany	2,000	....	Monthly	Simultaneous	20	Generally outside	5c. per meter
Americus	1,200	1,100	Monthly	Simultaneous	20	Outside	30c. per meter per year
Atlanta	33,000	....	Monthly	Simultaneous	30	Outside	80c. per meter per year
Augusta	7,500	7,300	Monthly	Simultaneous	20	Outside	12c. per meter per mo.
Commerce	360	355	Monthly	Simultaneous	20	Outside	$30 per month
Elberton	300	10	Monthly	Simultaneous	.....	Outside	.....
Fitzgerald	1,100	1,094	Monthly	Simultaneous	‡280	Outside	$68 per month
Gainesville	750	740	Monthly	Simultaneous	20-25	Outside	.....
Griffin	953	901	Monthly	Simultaneous	20, electric at same time	Most outside	$57 per mo.
La Grange	1,365	1,318	Monthly	Simultaneous	By one man in 4 days	Outside	4c.
Marietta	1,120	About 90%	Monthly	Simultaneous	2 men read water & electric 250 per day	Outside	About $95 per month
Savannah	1,600	1,360	Monthly	Simultaneous	About 12	Both	About $6.24 per year
Tifton	450	400	Monthly	Simultaneous	30	Outside	$15 per mo.
Idaho:							
Coeur d'Alene	97	75	Monthly	Simultaneous	All in 1 day	Half outside, half inside	$10 per month
Lewiston	1,200	1,150	Monthly	Quarterly	38	Outside	$33.50 per month
Twin Falls	40	20	Monthly	Simultaneous	10	Outside	.....

Illinois:							
Canton	1,100	Most	Residence quarterly, business monthly	By districts	....	Most inside	.....
Champaign & Urbana	5,002	4,700	Quarterly, large consumers monthly.	Simultaneous	20	Mostly inside	.....
Chicago	26,000	5,850	Monthly	In rotation	6 to 7	Some inside, some outside	$103,406.96
Chicago H'ts	2,366	2,200	Residence quarterly, factories monthly	Residences by districts	....	Both	.....
DeKalb	1,800	1,775	Quarterly	Simultaneous	....	Some inside, some outside	.....
Downers Grove	850	840	Quarterly	Simultaneous	....	Both	.....
Duquoin	250	230	Monthly	Simultaneous	$160	98% outside	6½c.
Lincoln	1,827	1,796	Monthly	3 districts	12	4 5 outside	.....
Mattoon	125	100	Monthly for large, quarterly for small.	Simultaneous	18	Outside	$25 per month
Mt. Carmel	25	15	Monthly	By districts	10	Mostly outside	.....
Mt. Vernon	1,313	1,263	Monthly	Simultaneous	....	Both	36c. per meter per year
Olney	530	510	Monthly	Simultaneous	27	Both	$65 per month
Paris	250	Majority	Quarterly	According to streets	20	Both	.....
Peru	1,650	1,550	Half yearly	Simultaneous	.....	Mostly inside	$700
Princeton	1,225	1,215	Quarterly	Simultaneous	$225	Inside	$150 per year
Quincy	4,826	4,680	Twice each quarter	3 districts	12	Mostly inside	$926.88 per year
Streator	2,265	2,000	Monthly	By districts	20	Both	.....
Watseka	700	600	Twice a year	In rotation	 15	Both	5c. per meter
Indiana:							
Bluffton	850	840	Semi-annually	Simultaneous	10	Both	.....
Brazil	1,000	970	Quarterly, some monthly	Simultaneous	25	Mostly outside	$56.92
Columbus	90	70	Monthly	Simultaneous	7	Both	$5 per month
Decatur	950	900	Quarterly	Simultaneous	10	Both	10c. per meter
Evansville	6,098	5,794	Large monthly, small quarterly	Simultaneous	....	Both	.....
Goshen	1,801	1,705	Quarterly	Simultaneous	12	Mostly in cellars	$287.36
Greenburg	100	50	Quarterly	Simultaneous	10	Various locations	.....
Huntington	2,417	2,000	Quarterly	By districts	25	Both	.....
Jeffersonville	390	315	Large monthly, small quarterly	Simultaneous	10	Both	.....
Kendallville	1,140	1,050	Quarterly	Simultaneous	....	Both	.....
Knightstown	580	577	Monthly	Simultaneous	25	Both	.....
La Porte	264	189	Monthly	Simultaneous	12	Boxes mainly	11c. each
Lebanon	1,510	1,450	Monthly	Simultaneous	20	Outside	.....
Linton	212	201	Monthly	Simultaneous	10	Both	.....
Madison	7	1	Monthly	Simultaneous	....	Both	50c. per hour
Mishawaka	2,474	2,424	Quarterly	Simultaneous	18	75% inside, 25% outside	$802.45
Newcastle	800	775	Quarterly	Simultaneous	12	Both	7c. each
North Manchester	525	509	Quarterly	Heaviest users first and down	10	Mostly inside	$480 a year
Plymouth	803	782	Every 2 months	Simultaneous	....	Mostly inside	.....
Richmond	4,117	4,009	About 50 monthly, balance quarterly	Simultaneous	10 to 15	Mostly inside	Reading 20c. each
Seymour	140	110	Monthly	Simultaneous.	....	Both	.....
South Bend	11,000	9,500	Residence quarterly, business monthly	In rotation	15	Both	.....
Terre Haute	7,307	7,077	Monthly	Simultaneous.	25	Mostly outside	$2,178.82; 2½c. per meter reading.
Tipton	800	790	Quarterly	Simultaneous.	10 to 15	Mostly outside	$75 per quarter
Valparaiso	1,225	1,187	Monthly	Simultaneous.	20-25	Most inside	.....
West Lafayette	125	100	Semi-annually	Simultaneous	....	Inside	.....
Iowa:							
Atlantic	250	235	Semi-annually	Simultaneous	10	Inside	$40 each time
Boone	1,864	1,850	Quarterly	Simultaneous	15	Both	$300 per quarter
Burlington	210	120	Monthly	Simultaneous	10	Mostly inside	12c. per month
Cedar Falls	1,292	1,235	Monthly	Simultaneous	35	Inside	$60 per month
Fort Madison	322	296	Monthly	Simultaneous	....	Inside	.....
Maquoketa	1,000	990	Semi-annually, 10 monthly	Simultaneous except monthly readings	17	Inside	.....
Marion	890	875	Monthly	Simultaneous	30	Inside	$20
Marshalltown	2,866	2,814	Quarterly	Simultaneous	10	Inside	.....
Mason City	3,000	2,850	Quarterly	Simultaneous	15	Inside	55c. per meter per quarter
Muscatine	2,500	2,300	Monthly	Simultaneous	25	Mostly inside	$30 to $40 per month
Osceola	110	110	Monthly	Simultaneous	....	Inside	.....
Sioux City	9,709	9,616	Monthly, quarterly and semi-annually	Simultaneous	12	Both	.....
Washington	1,000	950	Quarterly	Simultaneous	8	Inside	.....
Kansas:							
Atchison	476	369	Monthly	Simultaneous	12	Both	$45 per month
Chanute	2,175	2,160	Monthly	Simultaneous	....	Both	4c. per meter per month
Cherryvale	1,050	1,038	Monthly	.....	25	Outside	$50 per month

METERS—Continued.

City and State—	Number in use	Number under 1 inch	Frequency of reading each meter.	Billing simultaneous or in rotation.	Average number of meters read per hour per man.	Meters in building or outside.	Cost of meter reading and clerical work on meter accounts.
Kansas (Continued)							
Clay Center	962	873	Monthly	.....	....	Both	$70 per month
Council Grove	263	258	Monthly and quarterly	Simultaneous	10	Both	.....
Emporia	2,500	2,400	Monthly	Simultaneous	20	Mostly outside	5c per meter per month
Fort Scott	2,000	1,900	Domestic quarterly; commercial monthly	Simultaneous	30	Both	$120 per month
Fredonia	700	675	Monthly	Simultaneous	About 30	Mostly outside	.....
Great Bend	550	500	Monthly	Simultaneous	30 water and electric	Outside	5c per meter per month
Hiawatha	709	703	Quarterly	Simultaneous	25	Both	.....
Holton	484	480	Monthly	Simultaneous	20	Inside	$25 per month
Horton	350	349	Quarterly	Simultaneous	30	Both	$50 per year
Independence	2,053	....	Monthly	Simultaneous	....	Outside	.....
Iola	800 or 900	Almost all	Mostly quarterly	.....	....	....	.....
Larned	....	....	Quarterly	Simultaneous	30	Both	.....
McPherson	1,000	975	9 times a year	Simultaneous	20	Mostly outside	40c per hour
Manhattan	1,902	1,877	Quarterly; large consumers monthly	Simultaneous	25	Both	26c per acc't
Neodesha	950	935	Monthly	Simultaneous	30	Outside	.....
Osage City	425	420	Monthly	In rotation	20	Both	.....
Osawotamie	360	360	Monthly	Simultaneous	....	Both	.....
Ottawa	908	890	Monthly	Simultaneous	30 water and electric	Mostly inside	5c per meter per month for water and electric
Kentucky:							
Bowling Green	250	210	Monthly	Simultaneous	20	Both	About $200 per year
Frankfort	300	....	Monthly	Simultaneous	....	Both	.....
Hopkinsville	1,174	1,152	Monthly	Simultaneous	35	Outside	2½c per meter per month
Lexington	7,300	....	Monthly	Simultaneous	60	Curb line	.....
Louisville	5,865	3,875	Monthly	Simultaneous	20	Mostly outside	.....
Maysville	115	80	Monthly	Simultaneous	20	Both	.....
Paris	50	40	Monthly	.....	....	Both	.....
Somerset	479	450	Monthly	Simultaneous	15	Both	$2 per day
Louisiana:							
Kentwood	None	....	.....	.....	....	....	.....
New Iberia	200	100	Monthly	Simultaneous	All in 3 days	Outside	.....
Shreveport	3,754	97%	Monthly	10 districts	20	Outside	.....
Maine:							
Bangor	87	24	Monthly	.....	8.7	Mostly inside	$11.25 per month
Caribou	3	....	Quarterly	Simultaneous	....	Inside	$1.00
Eastport	750	725	Large consumers monthly, small quarterly	Simultaneous	24	Inside	.....
Gardiner	42	36	Monthly	.....	....	Inside	.....
Houlton	10	2	Quarterly	Simultaneous	....	Both	.....
Lisbon Falls	300	300	Quarterly	Simultaneous	....	Inside	$50 per year
Paris	7	6	.....	.....	....	Inside	.....
Sanford	1,200	1,190	Semi-annually	Simultaneous	10	Inside	$125 per year
Maryland:							
Baltimore	4,000	3,000	Quarterly	Simultaneous	15	Both	.....
Cumberland	800	783	Semi-annually	.....	....	Both	.....
Hagerstown	4,800	4,500	Large consumers monthly, domestic quarterly	.....	10	Inside	$2,000 per year
Massachusetts:							
Attleboro	3,067	3,045	Mostly quarterly, few monthly	Simultaneous	....	Inside	.....
Barre	25	23	Semi-annually	Simultaneous	....	Inside	.....
Belmont	1,712	1,600	Every 2 months	Simultaneous	15	Both	About $2,500
Cambridge	6,350	86%	Monthly	Simultaneous	9	Mostly inside	$1 per year
Cherry Valley and Rockdale	362	326	Quarterly	Simultaneous	....	Both	.....
Chicopee	2,780	2,580	Quarterly	By districts	18	Inside	$3,000
Danvers	100	60	Quarterly and monthly.	Simultaneous	....	Both	.....
East Weymouth	2,012	1,988	Quarterly	In rotation	12	Mostly inside	$520 per year not including billing
Fall River	10,342	9,600	Monthly	.....	10	Inside	.....
Falmouth	25	13	Most quarterly, some annually	Simultaneous	....	....	.....
Fitchburg	5,200	4,800	Large ones monthly, others quarterly	Simultaneous	12	Inside	.....
Franklin	1,103	1,088	Semi-annually	Simultaneous	‡100	Inside	$150 per year
Hudson	1,276	1,225	Quarterly	Simultaneous	20	Both	About $200
Mansfield	750	725	Semi-annually	Simultaneous	....	Inside	.....
Maynard	1,073	1,000	Semi-annually	Simultaneous	10	Inside	.....
Milton	2,055	1,155	Twice in 3 months	Simultaneous	5 to 20	Mostly inside	.....
New Bedford	14,852	14,252	Monthly	Simultaneous	12	Both	.....
Newburyport	98	....	Monthly	Simultaneous	....	Inside	.....
North Attleboro	1,475	1,425	75 monthly, balance semi-annually	Simultaneous	15	Inside	$200
Northampton	135	*30	Monthly	Simultaneous	1 man in 3 days	Inside	.....
North Easton	650	625	Quarterly	Simultaneous	1 man in 1 week	Inside	$25 per quarter, reading

Orange	909	894	Monthly	Simultaneous	45	Inside	$300 per year
Reading	1,688	1,634	Monthly	Two districts	....	Both	.....
Revere	2,682	2,345	Large consumers monthly, others quarterly	Simultaneous	15	Both	$2,800 per year
Somerville	10,166	9,970	Quarterly	By districts	15	Mostly inside	.....
Springfield	14,600	13,200	Quarterly	Rotation	....	Both	.....
Taunton	3,791	3,600	Monthly	Simultaneous	12 or 14	Mostly inside	.....
Walpole	930	863	Semi-annually, mills weekly	Simultaneous	3 to 30	Both	About $300
Waltham	3,372	3,270	Quarterly	Rotation	....	Generally inside	.....
Wellesley	1,588	1,400	Monthly or bi-monthly	Simultaneous	15 to 20	Inside	$22 to $24 per week
Worcester	20,715	19,460	Monthly	Simultaneous	About 14	Inside	$11,780.14
Michigan:							
Adrian	900	844	Commercial monthly, residences quarterly	Three districts	....	Inside	.....
Alpena	220	....	Quarterly	Simultaneous	....	Both	.....
Battle Creek	7,600	7,460	Small users every 2 months, large monthly.	Small ones alternately 1st of month	20	Both	$54 per year
Bay City	4,300	4,000	Large consumers monthly, others quarterly	Simultaneous	15	Both	9¾c.
Belding	830	800	Quarterly	Simultaneous	2 men 4 days	Both	$24 per quarter for reading
Benton Harbor	2,700	2,650	Residence quarterly, business bimonthly	Simultaneous	22	Both	.....
Holland	2,549	2,510	Quarterly	Simultaneous	16	Both	5c. per meter per quarter
Houghton	1,150	1,100	Quarterly	In rotation	10	Inside	$150 per month
Iron Mountain	600	575	Monthly	Simultaneous	....	Both	.....
Ishpeming	1,645	1,599	Quarterly	Simultaneous	....	Inside	$602.52
Boyne City	135	130	Quarterly	.....	10*	Both	.....
Grand Rapids	24,530	23,752	Quarterly	Rotation.	8†	Inside	$4,800 per year
Highland Park	1,120	1,000	Residence, semi-annual; business, quarterly	Simultaneous	10	Inside	.....
Jackson	9,000	8,020	Quarterly; large ones, monthly	Rotation.	....	Both	$345 per month
Lansing	11,286	10,982	Quarterly, about 250 large consumers monthly	Rotation.	30	Both	.....
Ludington	1,500	1,200	Quarterly	Simultaneous	15	Mostly outside	.....
Manistee	1,265	1,100	Quarterly	Simultaneous	7	Both	$75 per month
Manistique	17	9	Monthly	Simultaneous	....	Inside	None
Marshall	660	649	Residence, semi-annual; others monthly	.....	....	Both	$195
Mt. Clemons	1,940	....	Quarterly; business monthly	Rotation.	8 to 10	Both	$150 per month
Muskegon	4,050	....	Quarterly	Simultaneous	....	Both	.....
Niles	1,300	1,290	Quarterly; large consumers monthly	Simultaneous	....	Both	.....
Norway	104	90	Monthly	.....	....	Outside	.....
Traverse City	....	....	Quarterly	Simultaneous	16	Both	.....
Yale	15	12	Monthly	.....	....	Both	.....
Ypsilanti	1,370	1,340	Semi-annually	Simultaneous	10	Inside	.....
Minnesota:							
Chisholm	10	....	Monthly	Simultaneous	All	Both	.....
Duluth	12,144	98%	Monthly	By districts	15	95% inside	$0.3367 per meter
Ely	540	526	Monthly	Simultaneous	....	Mostly inside	About $160
Eveleth	35	30	Quarterly	Simultaneous	....	Mostly inside	.....
Minneapolis	60,930	50,000	Quarterly	Simultaneous	10	Inside	.....
New Ulm	900	800	Monthly	Simultaneous	....	Mostly inside	.....
Rochester	2,300	2,200	Quarterly; 50 monthly	Simultaneous	15	Inside	6c
St. Paul	37,380	34,961	Quarterly	Rotation.	11	Mostly inside	18.4c per year
St. Peter	305	275	Quarterly	Simultaneous	15	Inside	.$20
Mississippi:							
Corinth	8	4	Monthly	Simultaneous	3	Both	.....
Greenwood	....	....	.....	Simultaneous	....	....	.....
Water Valley	750	741	Monthly	Simultaneous	38	Outside	.....
Missouri:							
Boonville	424	404	Monthly	.....	14	Both	$20
Chillicothe	1,020	995	Monthly	Simultaneous	20	75% inside	$1,108.85
Farmington	450	446	Monthly	.....	....	Both	.....
Joplin	2,000	1,800	Monthly and quarterly	Simultaneous	15	Both	.....
Poplar Bluff	100	100	Monthly	.....	15	Both	.....
St. Louis	9,046	6,181	Monthly	Rotation.	12	Both	$1,449 per month
Trenton	1,064	1,050	Quarterly	Simultaneous	20	All kinds of places	.....
University City	3,600	90%	Quarterly	Rotation.	15	Both	$200 per month
Montana:							
Billings	2,935	2,855	Monthly	Simultaneous	20 to 25	Both	7c per meter per month
Kalispell	905	858	Monthly	Simultaneous	9	90% inside	$110
Libby	None	....	.....	Simultaneous	....	....	.....
Livingston	75	56	Monthly	Simultaneous	9	Inside	.....
Nebraska:							
Aurora	700	Nearly all	Quarterly	Simultaneous	....	Both	$20 per year for reading
Columbus	1,000	975	Quarterly	Simultaneous	100 per day	Both	.....
Hastings	2,672	2,630	Quarterly	Simultaneous	25	Both	$2,194.66
Lincoln	10,853	10,651	Quarterly	Rotation.	25	Both	16c per meter per year
North Platte	1,311	1,290	Quarterly	Simultaneous	12 to 15	Both	.....
Schuyler	365	358	Quarterly	Simultaneous	15 to 20	Both	.....

METERS—Continued.

City and State—	Number in use	Number under 1 inch	Frequency of reading each meter.	Billing simultaneous or in rotation.	Average number of meters read per hour per man.	Meters in building or outside.	Cost of meter reading and clerical work on meter accounts.
New Hampshire:							
Berlin	340	327	Quarterly	Simultaneous	15	Inside	.....
Claremont	954	....	Monthly	Simultaneous	20	Inside	65c. per meter per year
Concord	2,576	....	Once every 6 weeks	Simultaneous	20	Inside	.....
Lebanon	335	332	Semi-annually	.....	....	Inside	.....
Newport	4	4	Semi-annually	.....	....	Inside	.....
Portsmouth	3,238	2,993	Large ones monthly, residences quarterly	Simultaneous	8	90% inside	$3,000 per year
New Jersey:							
Atlantic City	7,398	5,182	Quarterly, large ones monthly	Simultaneous	40	At curb	.....
Bordentown	100	84	Quarterly	Simultaneous	20	Mostly inside	.....
Bridgeton	None	....	.....	.....	....	....	.....
Camden	1,350	900	Monthly	Simultaneous	10	Most inside	$5,000 per year
Garfield	2,025	2,000	Quarterly	Simultaneous	10	Inside	$190 per mo.
Hammonton	165	150	Quarterly	Simultaneous	10	Inside	.....
Harrison	1,681	1,555	Residence semi-annual, factories monthly	Simultaneous	10	Inside	.....
Hawthorne	500	495	Not read	Simultaneous	....	Inside	.....
Irvington	3,797	3,707	Quarterly	Simultaneous	19	Both	.....
Jamesburg	98	95	Semi-annually	Simultaneous	....	Inside	.....
Milltown	368	365	Quarterly	Simultaneous	15	Inside	.....
Newton	600	500	Quarterly	Simultaneous	....	Both	$32 per quarter
Nutley	1,700	1,600	Quarterly	Simultaneous	10 to 15	Mostly inside	.....
Pleasantville	1,150	1,100	Quarterly	Simultaneous	....	Both	.....
Rahway	154	140	Quarterly	Simultaneous	8	Inside	$35 per reading
Weehawken, Camp Merritt and 45 Municipalities	42,695	40,336	Quarterly, large concerns monthly	Simultaneous	18-22	Inside	.....
New York:							
Albany	8,200	7,235	Monthly	Simultaneous	8	Both	.....
Amsterdam	500	250	Quarterly	Simultaneous	....	Inside	$2,000 per year
Beacon	1,574	1,470	Quarterly	Simultaneous	8	Both	$350 per year
Canandaigua	1,788	....	Quarterly	.....	18	Most inside	$513.72
Corning	3,026	2,921	Quarterly	Simultaneous	18	Inside	$1,911.52
Dansville	None	....	.....	.....	....	....	.....
Elmira	10,032	9,894	Quarterly	Rotation, 3 districts	15 to 20	Inside	$1,839.02 reading
Frankfort	750	740	Quarterly	Simultaneous	....	Inside	.....
Fredonia	12	4	Semi-annually	Simultaneous	....	Inside	.....
Gloversville	4,300	....	Quarterly	Rotation, 3 districts	....	Inside where possible	.....
Herkimer	1,650	1,640	Residence quarterly, commercial monthly	Three districts	20	Inside	$40 per week
Hudson	250	200	Quarterly	Simultaneous	10	Inside	.....
Little Falls	919	855	Quarterly; mills monthly	Simultaneous	....	Inside	.....
Mechanicsville	1,100	1,087	Quarterly	Rotation	....	Inside	.....
Middletown	123	100	Monthly	Simultaneous	....	Inside	.....
Mt. Morris	13	9	Semi-annually	Simultaneous	....	Inside	.....
Mt. Vernon	5,818	5,679	Quarterly	Simultaneous	25	Both	.....
North Tarrytown and 5 other villages	2,399	2,332	Quarterly	Simultaneous	....	Inside	.....
Norwich	500	460	Quarterly	Simultaneous	....	Mostly inside	.....
Ogdensburg	118	75%	Monthly	Simultaneous	....	Mostly inside	.....
Olean	4,200	....	Quarterly	Simultaneous	15	Inside	$10 to $15 per month
Owego	660	651	Quarterly; large consumers monthly	Simultaneous	25	Inside	.....
Peekskill	3,000	2,900	Quarterly	Simultaneous	22	Inside	.....
Port Jervis	5	None	Monthly	In districts	10	Inside	.....
Potsdam	None	....	.....	Simultaneous	....	1 inside, 4 outside	.....
Poughkeepsie	5,500	5,000	Quarterly	.....	....	.....	.....
Rome	500	400	Quarterly	Simultaneous	10	Generally inside	$1,900 per year
Schenectady	800	700	Semi-annually	Simultaneous	....	Inside	.....
Sidney	None	....	.....	Simultaneous	2	Inside	50c.
Solvay	990	975	Semi-annually; large consumers monthly	Simultaneous	15 residential, 20 business	Inside	.....
Syracuse	28,133	27,169	Monthly	Simultaneous	20	Inside	.....
Tarrytown	1,005	80%	Monthly	Simultaneous	....	90% inside	$13,000
Tonawanda	40	18	Quarterly	Simultaneous	....	Both	.....
Troy	396	75	Monthly	Simultaneous	9	Mostly inside	Nominal
Waverly	500	470	Factories quarterly, houses semi-annually	Simultaneous	....	Inside	.....
Wellsville	750	742	Quarterly	Simultaneous	12 to 15	Inside	$391.27 per year
North Carolina:							
Concord	1,000	800	Quarterly	Simultaneous	35	Outside	$.05 per meter
Henderson	600	500	Monthly	Simultaneous	....	Outside	.....
Monroe	800	794	Monthly	Simultaneous	....	Both	.....
Statesville	932	850	Quarterly; extra large ones	Simultaneous			

Concord	1,000	800	Quarterly	Simultaneous	25	90% on curb	.....
Henderson	600	500	Monthly				
Monroe	809	794	Monthly			Outside	$384 for reading
Statesville	932	850	Quarterly; extra large ones monthly	Simultaneous	30		
Wilmington	2,500	2,400	Quarterly	Simultaneous		All but 20 inside	.....
North Dakota:					15		
Fargo	3,100	2,995	Domestic semi-annual; commercial monthly	Rotation		Inside	.....
Wahpeton	16	12	Quarterly	Simultaneous	....		
Ohio:						90% inside	$6,000 per year
Akron	26,000	25,000	Mostly quarterly	Rotation, 3 districts	28	Inside	$4 per day
Ashland	2,300	2,284	Quarterly	Simultaneous	25	Inside	.....
Athens	375	350	Every 6 weeks	Simultaneous	16	Mostly inside	$45.50 per month
Barnesville	1,000	900	Monthly & quarterly	Simultaneous	20	Both	.....
Bellefontaine	140	125	Every 2 months	Simultaneous	....	Both	.....
Bryan	700	....	Quarterly	Simultaneous	12	Both	$200 per month
Chillicothe	1,700	1,563	Monthly	Simultaneous	30	Mostly inside	$103,938 per year
Cincinnati	55,000	45,000	Monthly	Simultaneous	20	Both	$73,311.42
Cleveland	102,357	98,103	Quarterly; 1½" and over every 10 days	Simultaneous	25		.....
Conneaut	1,391	1,340	Residents quarterly; factories monthly	Simultaneous	25	Mostly inside	.....
Coshocton	200	160	Quarterly	Simultaneous	5	Inside	15c. per meter
Dayton	30,438	....	Large consumers monthly; small ones quarterly	In rotation	20 to 25	Mostly inside	$14,000 per year
Delaware	1,487	1,450	Large ones monthly; domestic quarterly	Simultaneous	10	Both	.....
Dover	74	58	Semi-annually	Simultaneous	....		.....
East Cleveland	4,646	4,522	Semi-annually	Rotation	....	95% inside	.....
East Liverpool	500	450	Quarterly	Simultaneous	20	Both	.....
East Youngstown	540	530	Small quarterly, large, daily	Simultaneous	....	Inside	$200 per month
Eaton	600	575	Monthly	Simultaneous	10	Both	.....
Findlay	3,700	3,500	Quarterly	Simultaneous	25	Outside	$2,400
Fostoria	2,800	2,790	Saloons & factories monthly	.....		Inside	.....
Girard	800	794	Quarterly	Simultaneous	1 man in 27 days	Inside	$100 per month
Lakewood	7,295	7,093	Quarterly	Rotation, 2 districts	15	Mostly inside	.....
Marietta	1,000	900	Quarterly	Simultaneous	15	Mostly inside	.....
Martins Ferry	130	75	Small meters quarterly, large ones monthly	.....	12	Most inside	11c per meter
Napoleon	918	900	Quarterly	Simultaneous	....	Both	.....
Newark	4,816	4,748	Quarterly	Simultaneous	20	Inside	.....
Piqua	None	....	.....	.....	....	....	.....
Ravenna	35	None	Monthly	Simultaneous	....	Outside	.....
Sidney	1,750	1,710	Quarterly	Simultaneous	....	Outside	.....
Steubenville	160	40	Quarterly	Simultaneous	25	Inside	$4.50 per day
Tiffin	2,380	2,321	Quarterly, large ones monthly	Simultaneous	10	Mostly inside	.....
Troy	1,737	1,712	Quarterly	Simultaneous	....	Both	$672
Urbana	335	305	Semi-annually	Simultaneous	35	Mostly inside	.....
Van Wert	900	875	Quarterly	Simultaneous	10	Both	.....
Wadsworth	300	292	Quarterly	Simultaneous	15	Inside	.....
Wilmington	617	607	Monthly	Simultaneous	....	One-third outside	$20 per month
Xenia	610	285	Mostly quarterly	.....	40	Two-thirds inside	.....
Oklahoma:				Simultaneous	....	Inside, if possible	
Durant	850	11	Monthly	Simultaneous		Outside	30c each per month
Oklahoma City	13,000	12,000	Monthly	By districts	‡100	Outside	$600 per month
Oregon:					25 to 30		.....
Baker	1,640	1,606	Small ones monthly from May to Nov.; large ones monthly	Simultaneous	About 25	Mostly inside	
Corvallis	1,800	1,775	Monthly	Simultaneous			75c each per year
Hood River	12	11	Monthly	Simultaneous	25	Both	.....
Klamath Falls	350	310	Monthly	Simultaneous	....	....	20c per meter per month
Marshfield & North Bend	90	70		In districts	20	Outside	.....
Portland	17,588	16,508	Monthly			Both	$2,400 monthly
Pennsylvania:			Monthly	Simultaneous	6	Outside	.....
Barnesboro	21	18	Monthly	Simultaneous	30		.....
Beaver Falls	3,946	3,700	Quarterly	Simultaneous		Both	.....
Bellefonte	106	....	Quarterly	Simultaneous	10	Inside	.....
Bradford	130	60%	Quarterly	Simultaneous	....	Both	.....
Carbondale	150	24	Monthly & quarterly	Simultaneous	....	Both	.....
Catasauqua	12	6		Simultaneous	....	Two-thirds inside; one-third outside	.....
Chambersburg	1,369	1,294	Monthly	Simultaneous	....	Inside	.....
Chester	13,685	13,308	Mfg. monthly; domestic quarterly	.....	....	Both	.....
Clearfield	132	79	Monthly	Simultaneous	....		45.6 cts.
Coraopolis	1,500	1,475	Semi-monthly	Simultaneous	16	20% outside	.....
East Stroudsburg	42	36	Quarterly	Rotation	10	Most inside	.....
Freeland	143	2	Semi-annually	Simultaneous	....	Both	Slight
Harrisburg	13,390	12,866	Monthly	In rotation	10	Inside	.....
Indiana	1,050	....	Majority semi-annually	Simultaneous	All in 1½ days	Inside	.....
Jersey Shore	28	23	Quarterly	Simultaneous	15	Inside	.....
Johnstown	6,353	6,044	Quarterly	Simultaneous	50	Mostly inside	.....
Juniata	3	1	Quarterly	Simultaneous	....	Inside	.....
Lancaster	6,521	5,741	Semi-annually	Simultaneous	16	....	.....
			Large ones monthly, others quarterly	Simultaneous	....	Inside	10c per meter
				Simultaneous	16	Both	

METERS—Continued.

City and State—	Number in use	Number under 1 inch	Frequency of reading each meter.	Billing	Average number of meters read per hour per man.	Meters in building or outside.	Cost of meter reading and clerical work on meter accounts.
Lewiston, 4 other municipalities & adjacent territory	134	87	Monthly	Simultaneous	....	Mostly inside	.....
Lock Haven	3	None	Quarterly	Simultaneous	....	Outside	Nominal
Meadville	3,376	....	Quarterly	Simultaneous	31	Inside	$1,088 per year
Medea	34	21	Quarterly	Simultaneous	All in 1 day	Inside	Nominal
Minersville	38	33	Quarterly and monthly	Simultaneous	....	Inside	.....
Mount Union.....	119	108	Mostly quarterly	Simultaneous	10	Both	$10
New Kensington...	3,200	3,100	Quarterly, large ones monthly	Simultaneous	12 to 15	Inside	.....
Rankin	880	865	Monthly	Simultaneous	20	Inside	$120 per month
Sewickley	120	59	Quarterly	Simultaneous	‡70	Both	$50 per year
Shamokin	105	60	Semi-monthly	Simultaneous	....	Inside	.....
Shenandoah	170	158	Monthly	Simultaneous	20	Mostly inside	$15
Susquehanna	....	All	Quarterly	Simultaneous	10	Inside	$1 per year per meter
Tamaqua	90	75	Monthly	Semi-annually	8	Both	.....
Uniontown	3,400	3,328	Monthly	Simultaneous	20	Mostly inside	$4,500 per year
West Newton.....	275	267	Mostly quarterly	Simultaneous	30	Mostly inside	.....
Wilkinsburg	15,680	Over 99%	Domestic quarterly; industrial monthly	In rotation	25	Inside	45c each per year
South Carolina:							
Charleston	7,101	6,752	Quarterly, industrial monthly	In rotation	10	Outside	.....
Cheran	180	170	Monthly	Simultaneous	25	Outside	$200 per year
Clinton	300	285	Monthly	Simultaneous	25	Outside	.....
Rock Hill.....	788	730	Monthly	Simultaneous	18	Outside	Reading, 2½c; office work, 5c
South Dakota:							
Aberdeen	1,850	1,820	Semi-annually; commercial monthly	Simultaneous	20 to 25	Mostly inside	Reading, $3.00 per year; Clerk, $85 per month
Rapid City.....	750	725	Quarterly	Simultaneous	10	Mostly inside	.....
Tennessee:							
Clarksville	500	350	Monthly	Simultaneous	25	Outside when possible	$15 per month
Dyersburg	888	863	Monthly	Simultaneous	15	Outside	4c per meter
Fayetteville	40	36	Quarterly	Simultaneous	13	Outside	$5
Franklin	500	All	Monthly	Simultaneous	20 to 40	Both	$75 per month
Knoxville	13,908	....	Monthly	Simultaneous	60 to 75	Outside	.....
Memphis	19,734	19,204	Monthly	3 districts	30	Outside	$13,000 per year
Union City.....	100	94	Monthly	Simultaneous	....	Outside	.....
Texas:							
Cleburne	2,600	2,590	Monthly	Simultaneous	30	Outside	4c per meter
Ennis	165	150	Commercial monthly, domestic quarterly	Simultaneous	....	Outside	.....
Hillsboro	1,150	1,050	Quarterly	Simultaneous	....	Both	.....
Longview	515	12	Monthly	Simultaneous	25	Outside	$27
Port Arthur.....	2,673	2,641	Monthly	Simultaneous	25	Outside	$415 per month

*Meters far apart. †Allowing for time to and from office. §In residence district. ‡Probably per day.

(Table to Be Continued.)

(*Continued from page 407*)

"Are all meters tested periodically?" "At what intervals?" "If not periodically, what determines when they should be tested?" "Are any tested without removal from the premises?" "If so, by what method or appliance?"

Some of the answers to certain of the questions were indefinite, but we did not take the liberty to change this form to a more definite one except in the few cases when we were certain of the facts. This is especially true of the answers to the question—"What is the average number of meters read per man per hour?" The large numbers named in some replies indicate that they must refer to the number read in a day, or by a number of readers.

Answers to inquiries concerning cost of meter reading and clerical work connected with meters, and the cost of repairs and maintenance of meters, are quite evidently not all on a uniform basis. This is natural, owing to the indefiniteness of the questions. But it seemed impractibale to make the questions more definite because of the great variety of methods of keeping accounts employed in the different cities. Some of the figures are definitely stated to refer to reading the meters only. Others give the salary of the clerk who has charge of the accounts. Some are for all meters for the year; others for all meters for one billing period (month, quarter, half-year, etc.); still others the average per meter per year or per billing period. In each case the reader must decide for himslf what is probably intended, in view of the size of the figure and the frequency of reading, combined with the explanation given. In general, the cost seems to average between 3 cts and 20 cts per meter per reading.

The cost of reading meters of course varies with the number one man can read in a day, and this is governed to a greater or less extent by the accessibility of the meters. As a general rule, we would expect to find that more meters can be read when they are located outside the houses than when inside, and this seems to be borne out by the figures. From 10 to 20 meters an hour is the range of a considerable percentage of the replies; but the total range is from 3 to all sorts of impossibly high figures.

The author of the latest work on water supply says: "Water meters are usually placed in the basements of buildings, but occasionally they are set outside of a building, and protected by a suitable box." Apparently the author's experience has been limited to the northern states. Taking the country over, the meters that are set outside are more than "occasional." Of the 427 replying to this question in our questionnaire, 101 report their meters set outside, 188 set inside, and 138 set some inside and some outside.

(*Continued on page 421*)

METER MAINTENANCE.

City and State.	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Alabama:						
Gadsden	..	All	Quarterly	.....	No	.....
Talladega	..	All cleaning, etc.	On complaint of consumer	In case of liberal users or waste and no excess reading shown	Nearly all	Closing all openings and drawing 10-gal certified cans several times
Arizona:						
Bisbee	...	...	.....	.....	...	.....
Clifton	$2.30	All	.....	When it stops running	No	.....
Arkansas:						
Fayetteville	50c. per mo.	All	.....	When in doubt as to accuracy	Few	Neptune meter tester
California:						
Alhambra	22c. per year	All	.....	If out of order or not tested for 6 months	No	.....
Anaheim	..	All	.....	.....	No	.....
Lodi	..	Worn parts replaced	.....	Complaint of customer	All	Barrel on scales
Los Angeles	30c.	All	.....	.....	No	.....
Oxnard	Negligible	...	.....	When they stop running	...	.....
Palo Alto	71c. per year	All	.....	As requested by consumers	No	Mueller met. tester
Pasadena	25c. repairs 50c. depr'c't'n	All	.....	Stopped or damaged	No	.....
Riverside	$2.30	All	.....	Suspicious readings	Yes	Portable test meter
Sacramento	...	...	.....	.....	...	.....
San Diego	90c.	All	.....	When repaired or when consumer pays for test	No	.....
Santa Maria	..	All	Annually	Consumption suggests	Yes	Test meter
South Pasadena	..	...	.....	.....	...	.....
Stockton	$1 per year	All	.....	Reading, testing and repairing	Yes	Chiefly test meters
Whittier	..	Replacement of worn parts	Annually, 2 men working all the time	Customer's request	Nearly all	Test meter
Colorado:						
Colorado Springs	..	All	Annually; some monthly	.....	Yes	Trident test meter
Fort Morgan	..	All	Annually	.....	No	.....
Greeley	..	...	Wil be	.....	Yes	Meter tester, measure, cubic foot
Rocky Ford	..	All	.....	.....	No	Laub tester
District of Columbia:						
Washington	28c.	About 30%	.....	.....	Yes	.....
Connecticut:						
Ansonia	65c., including reading	Cleaning & new parts	3 years 5 years	.....	No No	....
Derby	..	Nearly all		.....		
East Hartford	..	None	Annually	.....	Yes	Test meter
Hartford	..	All	Once in 5 or 6 yrs.	.....	Yes	Rated test meter
Middletown	21c. per year	All	.....	Stoppage or unusual readings	No	.....
Putnam	Small	Mostly all	.....	Unusual readings	No	.....
Southington	..	Nearly all	According to water passed; also check back on readings	Time they have been in, quantity of water drawn	Not gener'lly	Portable meter Clarke meter tester in shops
South Manchester	..	All not req. spec. fitting	All tested on setting and on complaint	.....	No	.....
South Norwalk	..	Few	When removed	When doubted	No	.....
Suffield	..	All	5 years	On complaints or stoppage	No	.....
Wallingford	$1 per year	Nearly all; 1½" to 4" sent to factory	6 years	Comparison of amount used each 6 months	Yes	Special testing (b)
Willimantic	..	90%	.....	.....	No	.....
Winsted	About 10c.	New disc only	.....	When bills are higher than usual	Yes	Installing a new next to old one
Florida:						
De Land	Very small	All	Not regularly	When fault is found	Yes	Draw cubic ft. of water by weight
Fort Myers	$1.00	All	.....	When cleaned, about once a year	No	.....
Miami	36c. per year	...	.....	Consumption suggests	Yes	Neptune portable test meter
Ocala	..	All	.....	Readings	Yes	Measured cu. ft.
St. Augustine	..	All	In rotation, except in case of leakage	Cleaned and tested once a year	Yes	Portable test meter
St. Petersburg	17c. per year	All	When repaired	If stopped or show defect, or customer's complaint	No	.....
Georgia:						
Albany	2c.	All	.....	As reading indicates	Yes	.....
Americus	25c. per year	Replacing all parts & upkeep	As often as practicable	c.	No	.....
Atlanta	..	All	At least every 3 years	When they have registered capacity	No	.....
Augusta	..	All	3 years	At consumer's request	No	Mueller testing bench by weight of water
Commerce	2c. (average of 10 yrs.)	All	.....	Decrease in usual consumption	Yes	Closing openings & measure of wght.
Elberton	..	All	Annually	.....	No	.....
Fitzgerald	$20 per mo.	All	Every 2 years	.....	No	.....
Griffin	15c.	Light rep.	.....	Troubles, complaints, diminution of consumption		
La Grange	.045c.	All	When necessary	Falling off of consumption	Few	Tested meter in ser.
Marietta	Very small	Few	Annually	Complaint of customer	...	.....
Savannah	..	All	When necessary	.....	Yes	Neptune test meter
Tifton	..	All	.....	When they show decrease	Yes	Portable tester
Idaho:						
Coeur d'Alene	..	All	2 years	.....	No	.....
Lewiston	..	All	When defects are noted	When repaired or moved	Yes	Test meter
Twin Falls	..	All outside	.....	.....	...	.....
Illinois:						
Canton	..	All	.....	When sluggish or dead	...	.....
Champaign & Urbana	..	All	5 years	At request of consumer	Yes	Test meter & 1 cu. ft. can.
Chicago	$3.02, including testing	All	.....	After certain amount of water has passed	No	.....

Of the 427 replying to this question in our questionnaire, 101 report their meters set outside, 188 set inside, and 138 set some inside and some outside.

(Continued on page 421)

stated to refer to reading the meters only. Others give the salary of the clerk who has charge of the accounts. Some are for all meters for the year; others for all meters for one billing period (month, quarter, half-

METER MAINTENANCE—(Continued).

City and State.	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Illinois—(Continued)						
Chicago Heights	..	All	.....	Variation in consumption	Yes	Portable test meter
De Kalb	Very small	Nearly all	.....	When suspected of error, or on consumer's request	No	.....
Downers Grove	..	All	.....	Falling off from average	Yes	Portable check met.
Duquoin	10c.	Meter only	2 years	.....	Yes	By weight
Kankakee	6c. per mo.	All where possible	.....	.....	No	.....
Lincoln	..	All	At least once a yr.	.....	No	.....
Mattoon	..	All	About 2 years	.....	Large ones	Test meter
Mt. Carmel	$2	Only replace parts	Annually	When they stop	Yes	Check meter
Mt. Vernon	6c. per year	All	.....	.....	Very few	Portable test meter
Olney	30c. per year	None	.....	When consumer is not satisfied	No	.....
Paris	..	By plumbers	.....	.....	No	.....
Peru	..	...	.....	When consumption is questioned	No	.....
Princeton	..	All	.....	Consumer's complaint or trouble reported by meter reader	No	.....
Quincy	30c.	All	About 5 years	.....	No	.....
Streator	..	All	4 years	When removed	No	.....
Watseka	10c.	All	.....	When consumers are not satisfied	Yes	Hand test meter
Indiana:						
Bluffton	..	All	.....	.....	No	.....
Brazil	..	...	.....	Before installed	Yes	Measure
Columbus	$12.50 per month	All	Semi-annually	.....	Yes	Check meter
Decatur	25c. per year	All	2 years	By Public Service Commission	No	Ford meter tester
Evansville	..	All	.....	Extra high or low readings	No	.....
Goshen	32c.	All	.....	When stoppage occurs	No	.....
Greensburg	..	All	Annually	.....	No	.....
Huntington	..	...	When necessary	By length of time in service	Yes	4 cu. ft. tank
Jeffersonville	..	All except unusual cases	.....	When stopped	No	.....
Kendallville	..	All	.....	Complaint by consumer or no registration	No	.....
Knightstown	..	All	2 years	If removed	No	.....
Laporte	16c.	...	.....	Unusual readings	No	.....
Lebanon	11c.	All	.....	.....	No	.....
Linton	..	All	.....	Variation in consumption or dissatisfaction	Not often	Test meter
Madison	..	None	.....	.....	...	.....
Mishawaka	15c. per year	All except new parts	.....	Decrease in registration	No	.....
New Castle	Probably 10c	All	When readings slow	Stoppage, complaint and reduction in bill	No	Meter tester
North Manchester	..	All	.....	When accuracy is questioned	Yes	Measuring water
Plymouth	Very small	Nearly all	.....	If necessary	...	.....
Richmond	51½c.	All, if possible	5 years, large consumers oftener	.....	No	.....
Seymour	..	Very limi'd	When considered necessary	Extreme variation	No	.....
South Bend	..	All	2 years	.....	Some	1 cu. ft. measure
Terre Haute	32c. in 1918	Nearly all	About 5 years, large meters oftener	Depends upon quantity registered	Very seldom	Large meter may be tested with smaller one
Tipton	..	All	.....	.....		
Valparaiso	..	Made by plumbers	Irregular but frequent	By any apparent irregularity	No	Mueller tester
West Lafayette	..	All	.....	.....	No	.....
					No	.....
Iowa.						
Atlantic	..	All	.....	When accuracy is questioned	No	.....
Boone	65c.	All	At least every 5 years	.....	Yes	By test meter or measuring can
Burlington	..	All	.....	When in shop for repairs	No	.....
Cedar Falls	Slight	Nearly all	.....	Complaints by customers	No	.....
Fort Madison	..	All	.....	When out of order	No	.....
Maquoketa	25c. per year	All	2 years	Comparison of readings and conditions	No	.....
Marion	$10 per mo.	All	3 months	.....	...	.....
Marshalltown	64c.	All	Expect to once a year	By readings	Will be	Portable tester
Mason City	..	All	.....	When repaired	Yes	Regular ⅝-in. meter to test large serv.
Muscatine	15c. to 20c. for labor	All	About 6 years	.....	No	.....
Osceola	..	None	.....	When they appear out of order	No	.....
Sioux City	..	All	When sent out	By readings	Yes	Test meter
Washington	30c. per year	All	.....	.....	No	.....
Kansas.						
Atchison	$1 per year	All	Large ones annually; small every 4 years	.....	No	.....
Chanute	12c. without labor	By storekeeper	.....	On complaint of consumer or reported dead by meter reader	No	.....
Cherryvale	40c. per year	All	Semi-annually	.....	No	.....
Clay Center	..	25%	.....	Reported by reader	Yes	Test meter
Council Grove	..	Very little	Irregular intervals	.....	Yes	by weight
Emporia	10c. per year	All	.....	Stopping of meter	Yes	Recording meter
Fort Scott	..	None	.....	Whenever necessary	Yes	Portable test meter, also 7½-gal. can
Fredonia	Probably 50c. per year	All	.....	Whenever necessary	Yes	Test meter
Great Bend	..	All	Annually	.....	No	.....
Hiawatha	60c. per year	About ½	.....	When meter stops	...	.....
Holton	50c. per year	All	.....	When considered necessary	No	.....
Horton	$25 for 350 per year	All except cleaning gear trains	.....	Don't need it	No	.....
Independence	..	...	.....	.....	Yes	Test meter
Iola	(d)	All	.....	Decrease in registration	Yes	By drawing off water & weighing
Larned	$25 per mo.	Nearly all	.....	When considered necessary	Yes	Test meter
McPherson	$1 per year	All	.....	When repaired or under suspicion	Yes	Checking meter

METER MAINTENANCE—(Continued).

City and State.	Cost of repairs and maintenance per meter in service.	Rep. made by water-works	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Kansas—(Continued)						
Manhattan	..	All	.....	On consumer's request	Yes	Portable met. tester
Neodesha	50c. per year	All	About 2 years	By unusual readings	No	.....
Osage City	..	All	.....	On consumer's complaint	Yes	Test meter
Osawatomie	..	...	.....	By readings	No	.....
Ottawa	..	Nearly all	.....	Inaccurate registration	Yes	Portable cubic foot measure
Kentucky.						
Bowling Green	$1.50 per yr.	Almost all	Semi-annually	If any unusual fluctuations	Yes	Test meter
Frankfort	..	...	.....	.....	...	.....
Hopkinsville	50c. per year	All	Whenever considered necessary	Monthly reading & inspection	No	.....
Lexington	33¼c.	All exc. machine work	⅝", 10 years, or after registering 100,000 cubic feet	.....	Yes	Measuring tank or scale
Louisville	..	All	.....	Variation of readings	Yes	.....
Maysville	..	Ordinary; worn meters sent to factory	Annually	By readings	Yes	.....
Paris	..	Minor	.....	.....	No	.....
Somerset	..	All	.....	When revenue falls off	No	.....
Louisiana.						
Kentwood	..	...	.....	.....	...	.....
New Iberia	..	Ordinary	.....	When they stop	No	.....
Shreveport	$1964.57 for 3754 meters in 1918	All	When changed	By consumption	No	.....
Maine.						
Bangor	$2.04	All	When deemed necessary	.....	No	.....
Caribou	None	None	.....	.....	...	.....
Eastport	..	All, except on large meters	.....	.....	Yes	Another meter and by measure
Gardiner	..	...	Annually in June	.....	No	.....
Houlton	..	...	.....	.....	...	.....
Lisbon Falls	5c.	Putting in new parts	.....	When stopped or repaired	No	.....
Rockland	..	All	3 or 4 times a yr.	Lack of revenue	No	.....
Sanford	..	All	.....	When found stopped	No	.....
Van Buren	..	...	.....	.....	...	.....
South Paris	..	...	.....	.....	No	.....
Maryland.						
Baltimore	..	All	.....	Inaccurate registration	No	.....
Cumberland	..	All	No system of testing	.....	...	.....
Hagerstown	20c. in 1918	Ordinary	.....	Variation in consumption	Yes	Neptune test meter
Massachusetts.						
Attleboro	..	...	.....	At owner's request	...	.....
Barre	..	...	.....	.....	No	.....
Belmont	..	Clean, set up & test	During sixth year	Stopped meters taken out of service	Yes	Master meter
Cambridge	$1.25 per yr.	All	.....	At request of consumer	No	.....
Cherry Valley	..	Nearly all	.....	Variation of readings	Yes	By meter
Chicopee	35c.	All	.....	At request of consumer, or if suspicious	No	.....
Danvers	..	Nearly all	.....	As needed	Yes	Meter tester
Easthamption	$900 a year	...	.....	When running slow or stopped	No	.....
East Weymouth	41c. in 1918	All ordinar'y	.....	When decreased readings noticed	Yes	Test meter for small, pitometer for large meters
Fall River	..	All	When necessary	For stoppage, etc.	No	.....
Falmouth	..	...	.....	.....	...	.....
Fitchburg	⅝" about $45	All minor repairs	.....	When necessary	No	.....
Franklin	Very small	All	About 5 years	By amount passed through	Some	Test meter
Hudson	$1.00	About ½	.....	When deemed necessary	No	.....
Mansfield	Small	All possible	.....	By way they run or when stopped	No	.....
Maynard	..	Cleaning & broken pa'ts	.....	When they stop or leak	No	.....
Milton	..	All	About 8 or 10 yrs.	.....	Yes	Trident test meter ¾ inch
New Bedford	88c.	About ⅞	5 years	.....	No	.....
Newburyport	..	Partially	.....	When out of order	...	.....
North Attleboro	60c.	About ⅞	When removed for repairs	When stuck	Some	Small test meter
Northampton	..	Very little	When necessary	By length of service	No	.....
North Easton	..	...	.....	.....	Seldom	Putting on one beside it
Orange	50c.	...	.....	When below average consumption	No	.....
Reading	..	75%	.....	.....	Few	Tank holding 1 c. f.
Revere	..	All	.....	By request or when repaired	No	.....
Somerville	..	Nearly all	.....	Opportunity	No	.....
Springfield	..	All	.....	When stopped or decrease in registration	...	.....
Taunton	$1.25 per yr.	All ordinary	4 years	.....	Seldom	.....
Walpole	Not over 15c.	All	As needed	By inspection	Yes	Test meter
Waltham	..	All	.....	When they slow down or on complaints	Yes	Master meter
Wellesley	85c. per year	Minor	.....	When slow or out of order or on complaints	No	.....
Worcester	59½c.	Nearly all	.....	When slow	Few	Filling a 1-ft. tank
Michigan.						
Adrian	..	All	2 years	.....	No	Weighing water
Alpena	..	All	Annually or oftener	.....	Yes	Test meter
Battle Creek	42c. per year	Nearly all	Never longer than 7 years	.....	Few	Portable ¾-in. test meter
Bay City	13.6c.	All	3 years if possible	Whenever property is vacant	No	.....
Belding	0420 yast yr.	All	.....	When opportunity offers	No	Weighing water
Benton Harbor	..	All	.....	By complaint	Yes	Box holding 1 cu. ft. water
Boyne City	..	All	.....	When deemed necessary	No	.....
Coldwater	..	...	.....	.....	...	.....

METER MAINTENANCE—(Continued).

City and State.	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Michigan—(Continued)						
Grand Rapids	$1.16 av. for ⅝" & ¾" meters	All	.....	On request or when repaired	No	.....
Highland Park	..	Minor	.....	By extreme variation in readings	No	.....
Holland	10c.	All	Irregular	Stop meters, removed meters, or unusual variation in readings	Yes	Test meter
Houghton	Very small	All	Quarterly	.....	Yes	Mueller tester
Iron Mountain	..	Minor	2 to 3 years	Action and average bills	No	Mueller tester
Ishpeming	$1245.91	...	.....	When out of order or consumer's complaint	No	.....
Jackson	..	All	Variable	.....	No	.....
Lansing	..	All	.....	When customers complain or by meter cards	No	.....
Ludington	..	All	Irregular	When meter is removed or bill drops	No	.....
Manistee	..	All	Annually	.....	Yes	Test meter
Manistique	..	All	.....	When out of order	No	.....
Marshall	Total last yr., $75	Nearly all	.....	By checking up average bills	No	.....
Mount Clemens	5c. per year	All	Some monthly	.....	Yes	Wght. & measurem't
Muskegon	..	All	As necessary	Overhauled after reading	No	.....
Niles	..	All	As they fall down	When they fail to register	No	.....
Norway	..	All except broken pa'ts	.....	When readings show variation	No	.....
St. Joseph	..	All	When received at shop	About 90 changed per quarter on account of sand	No	.....
Traverse City	..	All	.....	On large bills and when user insists	No	.....
Yale	..	Not many	.....	.....	No	.....
Ypsilanti	..	All	.....	Consumer's request and low readings	No	.....
Minnesota.						
Chisholm	..	...	.....	By inspection	...	.....
Duluth	$.1621 in 1918	All	.....	When premises are vacated	Very few	Tank measurement
Ely	..	All	.....	.....	Yes	Wght. & measurem't
Eveleth	..	...	.....	When they stop or underregister	No	Weighing water
Minneapolis	..	All	6 years	When repaired	No	.....
New Ulm	..	...	.....	When they stop	No	.....
Rochester	50c. per year	All	Quarterly as to condition	Length and amount of service	No	Mueller machine
St. Paul	..	All	.....	By decrease in registration or long period of service	No	.....
St. Peter	25c.	All	.....	When they slow up or stop	No	.....
Mississippi.						
Corinth	..	Installation only	.....	By comparative reading	...	.....
Greenwood	..	...	.....	.....	...	.....
Water Valley	$1.50 per yr.	All	When needed	When consumer has a big leak	Yes	Measuring water
Missouri.						
Booneville	..	All	.....	.....	...	.....
Chillicothe	About $1	All	.....	Slowing up, dead meter or consumer's request	Yes	Test meter or gallon measure
Farmington	..	All	.....	Consumer's complaint	Yes	.....
Joplin	..	All	1 to 5 years	.....	Yes	Smaller meter
Poplar Bluff	..	None	.....	.....	...	.....
St. Louis	..	All	.....	.....	Yes	Test valve
Trenton	..	All	.....	.....	No	.....
University City	15c. per mo.	All	Different intervals	When bill is too high	No	.....
Montana.						
Billings	..	All except burning & freezing	.....	By amount and kind of service	Yes	Test meter
Kalispell	About 2c.	All	When deemed necessary	By registration and other conditions	No	.....
Libby	..	...	.....	.....	...	.....
Livingston	50c. per year	All	Annually	.....	No	.....
Nebraska.						
Aurora	..	All from now on	Insist on every 2 years	.....	No	.....
Columbus	..	None	.....	When broken or stopped	...	.....
Hastings	34c.	All	2 years	.....	No	.....
Lincoln	36c.	Setting repaired meters	Over 1" annually	When requested or when they stop	Yes	Standard meter
North Platte	..	All	.....	Whenever taken out for rep.	Occasionally	Test meter
Schuyler	..	All	Not regularly; every 2 years	On consumer's request or suspicious readings	Yes	Connecting
New Hampshire:						
Berlin	..	Largely	Many annually and all at least every 6 years	When consumer desires	No	.....
Claremont	38c. per year	About 75%	.....	By amount of water passed	No	.....
Concord	$0.157	All possible	5 years	.....	No	.....
Lebanon	..	All ordinary	.....	When stopped	No	.....
Nashua	28c. per year average	All	6 years	.....	No	.....
Newport	Nominal	...	.....	.....	...	.....
Portsmouth	..	75%	When excessive	When excessive	Yes	Cubic feet measure
New Jersey.						
Atlantic City	..	...	.....	When they stop or register erratically	No	.....
Bordentown	50c. per year	All	.....	When readings are low	No	.....
Bridgeton	..	...	.....	.....	...	.....
Camden	$3 per year	95%	.....	On consumer's complaint	Yes	.....
Garfield	25c.	All	.....	On complaint or when below average consumption	No	.....
Hammonton	..	All	.....	When repairs are made	No	Measurer
Harrison	..	None	3 years	.....	No	.....
Hawthorne	..	...	.....	When they leak or stop	...	.....
Irvington	..	All	2 years	.....	No	.....
Jamesburg	..	All	2 years	.....	...	.....
Milltown	$.02	All	.....	Consumer's complaint or big change in bill	Yes	(e)

METER MAINTENANCE—(Continued).

City and State	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
New Jersey (Continued)						
Newton	..	Very little	.....	.....	No	.....
Nutley	..	None	.....	When working too fast	Yes	Test meter
Pleasantville	..	(f)	As required by Utilities Comm.	Amount passing meter	Yes	Portable test meter
Rahway	$2	All except large meters	.....	When they stop	No	.....
Weehawken, Camp Merritt & 45 municipalities	46½c. in 1918	All except large meters	When meter has registered certain amount, depending on size	.....	No	.....
New York.						
Albany	..	All	5 to 10 years	According to size and amt. of water passed	No	.....
Amsterdam	$1.50 to $3	All	When necessary	When complaint is made	Yes	.....
Beacon	50c. per year	All	.....	Amount of consumpton	Yes	Test meter 100%
Canandaigua	23c.	All	.....	When repaired or falls below average.	No	.....
Corning	39c.	All except frozen meters	Semi-annually	.....	Yes	Portable test meter
Danville	..	...	.....	.....	...	.....
Elmira	12c.	All	Intermittently	By readings	No	.....
Frankfort	..	None	.....	By cnodition at time of reading	No	.....
Fredonia	..	...	.....	.....	No	.....
Gloversville	..	All	According to use	.....	No	.....
Herkimer	..	All	Will be tested periodically	.....	No	.....
Hudson	..	All	.....	When apparently out of order	No	.....
Little Falls	..	All	.....	By general conditions	Some large ones	Hose and meter
Mechanicsville	..	All	.....	When not registering and below average reading	No	.....
Middletown	..	...	.....	Low reading and Length of service	...	.....
Mount Morris	..	...	.....	Apparent incorrect readings	...	.....
Mount Vernon	..	Minor only	.....	Consumer's complaint or decrease of bill	Yes	Gallon measure
North Tarrytown and 5 other villages	..	All	.....	.....	Yes	Various methods
Newark	..	All	.....	.....	...	.....
Niagara Falls	..	All	.....	When out of order or stopped	Yes	Trident tester
Norwich	About $1	All except factory rep.	.....	Consumer's complaint	No	Empire Meter Co.'s stand
Ogdensburg	50c. per year	General repairs	After repairs and before setting	By their condition	No	.....
Olean	..	All	.....	When they stop or run capacity of dial	No	Weight
Owego	..	...	.....	.....	No	.....
Peekskill	..	All	When necessary	When consumption seems abnormal	Generally	Weight & measure
Port Jervis	Nominal	Nearly all	.....	.....	No	.....
Potsdam	..	...	.....	.....	...	.....
Poughkeepsie	..	All	.....	By decline in size of water bill	Yes	Test meter
Rome	..	All	.....	.....	No	Test meter
Solvay	..	All	Large meters annually		Yes	Portable test meter
Schenectady	$4.50	All	Cleaned every 6 months	.....	Yes	Test meter
Seneca Falls	..	All	.....	Running slow or stopping	...	.....
Sidney	..	...	.....	.....	...	.....
Syracuse	$0.146	All	At least every 8 years	.....	Yes	Portable standard meter
Tarrytown	..	All meters 2" & under	When installed or repaired	When readings appear abnormally low	No	.....
Tonawanda	..	...	Annually	.....	...	.....
Troy	$3.40	None	2 years	On request of consumers or when readings fall off	No	.....
Waverly	..	Only on RR. & some factories	.....	When they appear to be incorrect	No	.....
Wellsville	40c. per year	Kept in good order	.....	When out of order	No	.....
North Carolina.						
Concord	..	...	.....	Consumer's request or broken down	No	.....
Henderson	..	All exc. 2" meters	.....	.....	...	.....
Monroe	..	All	.....	If consumer insists	Yes	Test meter
Statesville	50c. per year	Nearly all	Annually	.....	Yes	Standard meter
Wilmington	..	All	In future annually or biennially	.....	No	.....
North Dakota.						
Fargo	..	All	.....	At customer's request and when meter is removed	No	.....
Wahpeton	Very small	All	Semi-annually	.....	Yes	.....
Ohio.						
Akron	..	All	All 1½" and over, quarterly to annually	If registration is slow	2" & over	Test tee left in line & connected by hose to test meter
Ashland	..	All	.....	In winter months	No	.....
Athens	Not much	Nearly all	.....	Whenever read	Yes	3-gal.container
Barnesville	40c.	All	.....	When they fail to register	No	.....
Bellefontaine	..	All	.....	.....	No	.....
Bryan	50c.	All	.....	When not runnng	No	.....
Chillicothe	..	All except frozen and strained	.....	When readings fall off	Yes	Portable meter
Cincinnati	..	...	.....	By unusual registration	No	.....
Cleveland	37c.	All	Large meters annually	After certain consumption	Yes	Hose and meter
Conneaut	..	...	When not registering	When bills appear low	No	.....
Coshocton	..	Slight repairs	.....	Apparent excessive use	No	.....
Dayton	About $1	All	.....	Test "dead" meters first	Yes	Measuring device
Delaware	..	Nearly all	.....	When consumption less than average	No	.....
Dover	50c.	All	.....	.....	No	.....
East Cleveland	..	All	.....	General conditions	No	.....
East Liverpool	..	...	.....	.....	No	.....

METER MAINTENANCE—(Continued).

City and State	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Ohio—(Continued)						
East Youngstown	$2 per year	All	Annually	.....	Yes	Neptune meter tester
Eaton	..	All	.....	When repaired	No	Test meter
Findlay	25c.	All	.....	When consumption falls off	No	.....
Fostoria	..	All	2 year	When repaired in shop	No	.....
Girard	2c.	All	.....	When deemed necessary	Yes	Approved U. S. gal.
Lakewood	..	All	Irregular	After registering 180,000 cu. ft.	No	.....
Marietta	..	Very little	.....	.....	...	.....
Martins Ferry	10c. to 12c.	...	.....	At consumer's request when out of order	No	Weight of water
Napoleon	..	All	.....	When they fail to operate	No	.....
Newark	..	All	Expect to periodically	When readings show decline	No	.....
Piqua	..	...	.....	.....	...	.....
Ravenna	..	All	9 months	Comparison of readings	No	.....
Sidney	..	All	.....	When they stop or register low	No	.....
Steubenville	Very little	Small work	Expect to periodically	When meter fails to register.	No	.....
Tiffin	70c. for 1918	So far as possible	3 years	.....	Yes	Buffalo test meter
Troy	30c. per year	All	.....	When stopped or slow	Yes	Test meter
Urbana	..	All	.....	When deemed necessary or consumer's complaint	No	.....
Van Wert	75c.	All except new parts	.....	When found dead, and repair'd	No	.....
Wadsworth	..	All	Not determined	.....	...	.....
Wilmington	4c. per mo.	All	.....	On customer's request for excessive bills	Yes	Standard tested measure
Xenia	..	Small repairs	Not until they stop	When bills do not average up	No	.....
Oklahoma.						
Durant	13c. per year	All	Annually	.....	Yes	Portable test meter
Oklahoma City	..	All	.....	Whenever taken out and reset	Yes	Measuring
Oregon.						
Baker	..	All	.....	.....	...	.....
Corvallis	25c. per year	All	.....	Noticeable change in registration	No	.....
Hood River	..	...	.....	.....	...	.....
Klamath Falls	Negligible	All	.....	On complaint of customer or irregularity	No	.....
Marshfield	..	All	Annually	.....	No	.....
Portland	10.8c.	All	When repaired	When they stop registering	No	.....
Pennsylvania						
Barnesboro	..	All	Annually	Customer's complaint	No	.....
Beaver Falls	..	All	.....	.....	No	.....
Bellefontaine	..	...	.....	.....	Yes	.....
Bradford	..	All minor	Annually	.....	...	.....
Carbondale	..	Nearly all	Annually	.....	No	.....
Catasauqua	$5 a year	None	.....	When deemed necessary	No	.....
Chambersburg	..	All	10 years and when repaired	.....	No	.....
Chester	$0.438	All	4 to 10 years	.....	...	.....
Clearfield	..	Small repairs	.....	.....	No	.....
Coraopolis	..	All	.....	By irregularity in reading	No	.....
East Stroudsburg	$10 per year	None	.....	When they fail to register	Yes	Standard measure
Freeland	..	All	Monthly	.....	No	.....
Harrisburg	..	About 96%	.....	By inspector's condemnation	No	.....
Indiana	..	All	.....	At customer's request	Yes	Attaching perfect registering meter
Jersey Shore	Very small	None	.....	.....	No	.....
Johnstown	..	All	3 years	.....	...	.....
Juanita	Very small	All	Not regularly	....	Yes	Neptune water tester
Lancaster	7c.	All	5 years	.....	No	.....
Lewiston, 4 other municipalities and adjacent territory	..	Replacing new parts	As required by People's Service Commission	When new parts are put in or meters are defective	Yes	Test meter
Loch Haven	..	...	.....	.....	Some	Test meter
Meadville	41c.	All	.....	After registering certain amt.	...	.....
Media	Nominal	...	.....	When required	No	.....
Minersville	..	All	5 years on ⅝	.....	...	.....
Mount Union	$2 per year	All	When necessary	Customer's complaint	Yes	Portable tester
Rankin	31c. in 1918	All	No stated intervals	Variations not otherwise explainable	Yes	.....
Sewickley	$60 per year	All	.....	When out of order	No	.....
Shamokin	..	All	Annually	.....	No	.....
Shenandoah	..	Replacing parts	.....	By monthly inspection	No	.....
Susquehanna	50c. per year	...	.....	On complaint	No	.....
Tamaqua	..	Cleaned each year	.....	When cleaned and inspected	Yes	Water measured
Tyrone	..	None	.....	By comparative monthly readings	No	.....
Uniontown	..	90%	.....	When they stop, or by request	No	.....
West Newton	$1 per year	All	5 years	Consumer's request	Yes	Tank
Wilkinsburg	$.658 per yr.	All	No regular intervals	By rules of Public Serv. Com.	No	.....
South Carolina.						
Charleston	..	98%	.....	.....	No	.....
Cheraw	25c.	None	.....	Upon complaint or suspicion	Yes	Test meter
Clinton	Very small	All	.....	Customer's complaint	No	.....
Rock Hill	..	All	.....	When readings indicate necessity	Yes	Standard test meter
South Dakota.						
Aberdeen	40c. per year	All	.....	When readings indicate necessity	No	.....
Rapid City	Nominal	All	.....	.....	No	Master test meter
Tennessee.						
Clarkville	15c.	All	Quarterly, semi-annually and annually	Upon service each meter gives	Yes	Connecting perfect meter on outlet line
Dyersburg	..	All	2 years	.....	No	.....
Fayetteville	..	...	.....	When in need of repairs	No	.....
Franklin	About $1	Nearly all	.....	When reading indicates necessity	Yes	Measuring flow
Knoxville	..	All	.....	When not registering	No	.....
Memphis	45c.	99%	.....	When consumption decreases	Yes	Portable test. meter
Union City	..	...	.....	.....	...	.....

METER MAINTENANCE—(Continued).

City and State	Cost of repairs and maintenance per meter in service.	Rep. made by waterworks	Intervals at which meters are tested	Meters not tested periodically, but	Are any tested without removal	Method of such testing
Texas.						
Cleburne	3c. per mo.	All	.....	If stopped or out of order	Yes	Measure
Ennis	..	All	When they fail to register	When accuracy of meter is questioned	Yes	Measure
Hillsboro	..	All	.....	When they fail to register	No	.....
Longview	6c.	All	.....	When necessary or requested by consumers	No	.....
Port Arthur	1.7c. last year	All	.....	By variations in consumption	Yes	.....
Temple	..	All	.....	When they fail to register	Yes	Test meter
Weatherford	..	All	When necessary	When consumption is unusual	Yes	Cubic feet measure
Vermont.						
Fair Haven	50c.	All	.....	When out of order	...	.....
Montpelier	..	All	.....	.....	No	.....
Northfield	..	Nearly all	5 years	When readings show slow	Yes	1 cu. ft. tank
Richford	Nothing as yet.	...	.....	By complaint	Yes	.....
Virginia.						
Danville	..	All	.....	By monthly observation of readings	Yes	Measurement
Fredericksburg	..	None	.....	By variation in reading	Will be	Measured tank
Richmond	..	All	.....	On complaint or when repair'd	Very few	Meter tester
Pulaski	..	...	.....	.....	...	.....
Washington.						
Centralia	$1 per year	All	2 years	.....	Yes	Weighing 1 c. f. on various loads
Chehalis	17c. per mo.	Minor	No regular intervals	On consumer's complaint or drop in consumption	No	.....
Ellensburg	25c. per year	All	Annually	.....	No	Test meter
Hoquiam	20c. per year	Nearly all	3 years	.....	Yes	Portable test meter
Olympia	10c. per year	All	.....	When necessary or at consumer's request	No	.....
Port Townsend	25c. per year	All	As needed	By carefully watching consumption	No	Measuring by tank
Pullman	About 8c.	20%	.....	When consumption is above minimum 5,000 gals., if small consumer	Yes	Meter and scales
Seattle	72c. per year	All	.....	When out of order or unusual monthly consumption	No	(g)
Spokane	About 3c.	All	3 years for business meter	Whenever record indicates it necessary	No	.....
Walla Walla	..	All	Within 3-year period	.....	Some	Test meter
Wenatchee	$1.24	All	Annually	Consumer's request	No	.....
West Virginia.						
Elkins	Very small	...	Annually or oftener	When requested	No	.....
Princeton	30c. per year	All	4 years	.....	No	.....
Wisconsin						
Beloit	12c.	All	.....	.....	No	.....
Columbus	..	All	2 years	When complaint is made	Yes	Bucket method
De Pere	Very small	...	.....	.....	Yes	Measuring with a gallon measure
Eau Claire	12c. in 1918	All	.....	If dead, removed for repairs or changed	No	.....
Fond du Lac	$728.10 total per year	All	No certain intervals	High bills and stopped meters	Yes	7½ gal. measure
Grand Rapids	68c. per year	All	.....	As we can spare time	No	.....
Green Bay	..	All	.....	By consumer's request—and that is often	Yes	Weight or measure
Janesville	$20 for 1350	All	.....	By size of bill	No	.....
La Crosse	29c.	All	Consumer's request	When readings indicate falling off in consumption	Yes	(h)
Madison	52c. per year	All	Not less than 3 years	When they stop or leak	No	.....
Menominee	..	Cleaned	.....	At customer's complaint	Yes	Measurer
Milwaukee	48c.	All	Large ones, annually	Falling off of registration, defect, or consumer's request	All above 2"	.....
Portage	..	All	Semi-annually	.....	No	.....
Shawano	..	Frozen meters only	.....	When repaired or on complaint	Yes	Accurate meter
Stevens Point	20c. per year	All	9 to 12 months	.....	Yes	Measure
Watertown	10c.	All	3 years	When reading shows drop in consumption	Yes	Portable test meter
Wyoming						
Green River and Rock Springs	..	All except larger sizes	.....	When necessary or at customer's request	No	.....

(a) Also when meter reader determines that registration at any particular place is unusually low, or when stuck or out of order. (b) All large meters are set with 2 gates and a tee with ¾" plug, so that meter can be tested in place. (c) Important consumers' meters tested often and others as rapidly as possible. Interim not over 2 or 3 years. (d) Party buys meters—must keep up all repairs. (e) Put meter in tandem with tested meter and draw off water in 5-gal. measure at different speeds. (f) All repairs to distribution system up to curb line. (g) A given volume run through meter must give proper registration in cu. ft. (h) Cu. ft. measure proved and scaled by scals and weight and measure.

(*Continued from page 414*)

The great diversity in frequency of reading meters is quite interesting. Readings are reported as being made at intervals varying from one day to six months. The majority read monthly, with quarterly readings next in popularity.

Quite a number of cities make out bills by districts in rotation, thus enabling one man or set of men to keep continuously at the work of reading and making out bills. Where bills are sent quarterly, a common practice is to divide the city into three districts, which receive their bills on the three successive months of each quarter. This avoids the periodic dropping of everything else by all hands to get out the bills, the man or men who attended to this giving it almost exclusive attention and requiring no aid from the rest of the force. In spite of its apparent advantages, only a few cities have yet adopted this plan.

The regular testing of meters should, in our opinion, be more generally practised; not necessarily frequent testing, but securing assurance as to each and every meter once in every one, two, or three years that it is registering within a desired limit of accuracy. Of course, all meters are watched, and a test is made if they seem to register suspiciously.

WATERWORKS OFFICE APPLIANCES.

Addressing Machines and Adding Machines Found in Large Percentage of Offices—Other Appliances Used—Waterworks as a Business.

A waterworks office is a business office, and should be conducted as such. The receiving of the payments from the consumers is a business transaction very important to the welfare of the department or company. The correct keeping of the accounts of the consumers is a duty of the management that is most important both for insuring that the consumers pay all that they owe, and for inspiring in them a confidence in the management.

In some towns we find that the office is also used as a store room for tools, valves, meters, and other of the smaller and more valuable materials that are kept on hand; the office part, in fact, being confined to a desk that is crowded into one corner near the door. In our opinion, this is wrong. In an indistinct and unrealized way it is apt to impress the visitors to the office as typifying the superintendent's mind—as indicating that he is a mechanic by whom the business end of his job is given scant consideration. And often that estimate is about correct. But it should not be, for the correct accounting and handling of the money taken in is as important to the enterprise, whether municipal or private, as is the proper use of the money paid out for maintenance and construction.

Let the superintendent put up a partition between the office in front and the store room behind. And let him take off his overalls and put on his coat when he works on the accounts, even if alone; for this change in exteriors will help to effect a change in mental viewpoint, and to make him, for the time being, a business man in sympathy with business methods.

But the number of offices where unbusinesslike methods prevail is growing smaller rapidly. Nearly four hundred and fifty superintendents have reported to us the labor-saving appliances used in their offices, these covering all sizes of municipalities and in all parts of the country. Where such appliances are used it may safely be assumed that there is an earnest effort to employ business methods. A condensed statement of the numbers in use in these four hundred odd offices is as follows:

Addressing machines, 186.
Adding and other calculating machines, 310.
Envelope sealers, 17.
Stamp affixers, 14.
Cash registers, 8.
Bookkeeping machines, 6.
Billing machines, 6.
Letter-duplicating appliances, 6.
Automatic change makers, 6.
Coupon clipping, stub clipping, and receipt cutting machines, 8.
Numbering machines, 2.
Receipting machines, 2.
Folding machines, 2.
Dictaphones, 2.

And one each of letter opener, booking machine, check writer, and stencil cutter. Probably the majority use typewriters, although only a few mention them. Others name, as labor-saving devices, a card system of keeping accounts, instead of ledger, and the use of "window" or "outlook" envelopes. One reports his only labor-saving device as being a pencil sharpener, and "that belongs to me."

The superintendent of the Division of Water, of Dayton, O., says:

"In the labor saving office appliances, it seems well to mention our cash registers, one of which was installed last year, and the other one this year. These machines belong in every municipal water works. They enable the cashier to know at a glance how much money should be in his drawer. They show the person who pays a water bill the exact sum which was received from him, which is often more or less indefinite where discounts are given for prompt payment, or penalties added for delayed payment. They protect the water company in that the stubs which the company receives also show the payments made, and greatly facilitates the checking up or correction of mistakes which may have entered and which must absolutely be eliminated from municipal bookkeeping. Every municipal employe knows that his accounts must balance to the cent, or else a state auditor will pass certain disparaging remarks on the employes who are responsible for same.

"The public would not deal with a store that had an improper system of receiving money, where all payments do not go through the cash register, and they have the right to expect as much where their own money is being handled." (We seem to recall that a popular brand of cash register has its home in Dayton.)

The above list indicates that some offices, at least, employ all or most of the devices to be found in the most up-to-date business office. About three-fourths of the offices use adding or other calculating machines. More than forty per cent use addressing machines. (Some have the addressing done outside by offices making a business of it.) But here we come to a sudden stop. Apparently no other device is used by more than four per cent of the offices, and only two by more than two per cent.

For the smallest offices, of two or three hundred accounts made out and collected quarterly, most of the appliances named would really be unnecessary and would not pay for themselves in the labor saved. But a city of, say, 100,000, with about 16,000 accounts to keep and the same number of bills to make out and checks or cash payments to receive and acknowledge within six days each month, many of these devices should be labor savers. Even with 30,000 population the number of accounts would be about four or five thousand, and to bill this number in one week would mean almost two a minute; and a labor-saving device might easily save one employe's salary.

MAINTAINING SMALL WATERSHEDS.

In his annual report for 1918, the city engineer of Little Falls, N. Y., John E. Foote (who acts as engineer for the municipal waterworks), described the work on the water sheds of the several sources of supply. Beaver Creek, above the reservoir, was cleaned of all logs, brush and other rubbish which had accumulated along its entire length, and brush and trees along the edges of the stream were cut and burned. The work of reforesting the watershed of this creek was continued, 10,000 trees being planted. Of these, 2,000 were black locust, which will be used for posts for fencing the city's property. Also numerous sanitary surveys were made of the entire watershed.

A tract of over 8 acres on another water shed was planted to potatoes, and over 700 bushels of excellent quality were sold in the city at $1.50 a bushel. This was done largely from patriotic motives.

Cleaning up and reforesting watersheds and giving them frequent sanitary inspection are too often neglected, we fear, especially where the watersheds are small; but they are nevertheless very important maintenance features.

The WEEK'S NEWS

U. S. Road Bureau Making New Tests—Missouri's Road Law Constitutional—Iowa's New Road Law—Eliminating Health Menaces in Toledo—Filtration Plant for Sacramento—New Manager for Boulder, Colo.—City Employes' Council in English City—Airships Fighting Forest Fires—Two-Platoon System for New York City—Air Terminals in Thirty-two Cities—Municipal Markets in the United States.

ROADS AND PAVEMENTS

Government's Highway Test Experiments.

Washington, D. C.—A new series of important experiments has been started by the Bureau of Public Roads, Department of Agriculture. The work which is being done by the Division of Road Materials Test and Research is designed to investigate damage done to highways by different forms of transportation units traveling under various conditions. It is thought that the information so obtained will perhaps serve as a basis for scientific regulation of traffic on different types of pavements, incidentally indicating the types and designs of road which will best serve the needs of the traffic. It is also suggested, that from this knowledge fair consideration will be assured in legislative impositions on traffic, since an accurate measure of impact damage therefrom will be possible. The experiments will cover a wide range, taking into account four factors, those of speed, height of fall, type of tire used, and the weight of the transportation unit. Under the last heading it will be necessary for the bureau to consider distribution of weight above and under springs and on back and front axles, a quantity which is decidedly variable on different makes of motor and horse-drawn vehicles. The bureau has called upon the National Automobile Chamber of Commerce to assist in the collection of this data much of which has not been generally tabulated, and a questionnaire has been sent to all motor truck manufacturers of America on this subject. In the initial stages of the work the impact has been measured by the permanent deformation of ½x½-inch copper cylinders placed under a steel plunger subjected to the impact of traffic. A varying height of fall is arrived at by different take-offs for the machine. First experiments indicated a wide range in the force of impact as between units with solid tires and pneumatics. Working from these first steps, the bureau officials plan to perfect a machine which will take into account the factors mentioned and which will enable them to provide a constant succession of impacts on selected slabs of paving compositions. This will enable the experiments to proceed much more rapidly than would be possible under actual road conditions. Tests will be made of horse-drawn as well as motor-driven vehicles. In addition to the above experiments another series is planned to determine the wearing qualities of different types of road surfaces when subjected to very heavy traffic.

Utilities Commission Has Power Over Highway Traffic.

Salt Lake City, Utah—The powers and right of the public utilities commission of Utah in regulating stage travel over all the roads of the state have been decided in the supreme court. In a decision written by Chief Justice E. E. Corfman and concurred in by the four other justices of the court, it was decided that the Third District Court had erred in dismissing the case of the public utilities commission against Parley Jones for nonsuit. It was held that a case does exist and Justice Frick states the reason as follows: "Any road or highway which is thus being used by the public generally is, in my judgment, a public road or highway * * * over which the travel and traffic is subject to regulation by the commission." The lower court held that the defendant, in asking for a dismissal of the case against him, had established that the road over which he was asking a right to operate a stage line between Bingham and Copperfield was not a stage road and the state utilities commission had no jurisdiction over it. For this reason, it was believed, he could not be constrained from operating a stage line without the permission of the utilities commission. The case was brought into court after repeated requests to quit operations had been disregarded. The above decision establishes the jurisdiction of the public utilities commission to control stage traffic over any and all roads in Utah. There has been some question in the past regarding the rights of the commission in controlling stage travel on roads not commonly known as state roads. The road between Bingham and Copperfield was shown to be a changeable road. The defendant in supporting his case argued that the road was not fixed and stationary; that it had been changed from one side of the canyon to the other in the past ten years. Chief Justice Corfman defines a road from the compiled laws of Utah, section 2,800, as follows: "In all counties of this state, all roads, streets, alleys, lanes, courts, places, trails and bridges laid out or erected as such by the public, or dedicated or abandoned to the public, or made such in actions for the partition of real property, are public highways." The appellant contended that the canyon road in question, while admitedly located in many different places in the last ten years, has been during all this time the only thoroughfare between the two places. It is upon this point that the supreme court reversed the decision of the lower court.

Missouri Road Law Constitutional.

Jefferson City, Mo.—According to advices from Washington, the Missouri Road law authorizing county officials to issue road bonds and levy taxes therefor upon a vote of county residents, has been declared constitutional by the United States Supreme Court. The case involved disposes of proceedings concerning the validity of $3,000,000 road bonds issued by St. Louis County.

Iowa's New Road Law in Effect.

Des Moines, Ia.—The Iowa road law which inaugurates a new era in road building in the state, is now in full force and effect. There can be no hard surfacing under this new law unless the county so votes. This provision was written into the law in the form of a senate amendment before the senate could get an affirmative vote on the road bill. The state highway commission estimates that only about 1,500 miles of the 6,000 miles of primary roads are put to grade or drained. The primary roads are the roads which run from county seat to county seat across the state. Hence there is a long tedious job ahead in grading and draining these roads properly before any hard surfacing can take place. There will be no special assessments to pay for the cost of grading and draining. This cost will come out of the federal aid and motor license money, or in other words the primary fund. It is only when hard surfacing is to be undertaken as voted for by the people that assessment districts will be fixed. The amount of money for the improvement and maintenance of the roads outside the primary roads or county seat roads as they are more generally recognized will be larger under this new law than heretofore, so that such roads need not be neglected while the inter-county roads are paved. The new road law provides that all of the present road

taxes will go to these secondary and township roads and the two mill road building fund, which has heretofore been levied on farm property only, has been spread over all of the property in the county. This will therefore give the secondary roads more money than they have ever had before. The following outline of the law was prepared by senator W. G. Haskill, Eastern State District Canal, Lincoln Highway Association, Cedar Rapids:

1. Specifies an inter-county seat system of primary highways, totaling about 6,000 miles. This system to be completely hard surfaced as soon as possible.

2. Pledges the state's full co-operation to the Federal Government by the appropriation of any necessary amount to meet Federal Aid allotted to Iowa. Iowa's Federal Aid up to period ending July 1, 1921, amounts to about eight million dollars. This fund, together with an equal amount from receipts on licenses on motor vehicles, constitutes the primary road fund for the construction of the inter-county seat system of hard surfaced roads.

3. The total primary road fund is proportioned to the counties of the state in the ratio that their area bears to the total area of the state. The counties of the state may grade and drain all the primary roads within the county before laying any hard surfacing, or they may proceed at once to hard surface as rapidly as the annual allotment is available, or issue bonds for the immediate undertaking of permanent construction of their primary roads.

4. Provides that before any hard surfacing can be undertaken by the county board, the question must be submitted to the voters of the county. Provides that each county must lay out a systematic program for the development of its primary system. The cost of the improvement of the primary roads to be borne three-fourths from the primary road fund, one-fourth from assessments on specially benefited property located in the zones one and one-half miles in width on each side of the road.

5. All plans, specifications, contracts, etc., entered into by the counties for the construction of primary roads are under the full control and supervision of the state highway commission.

6. Any county may without a bond issue, without a vote of the people and for the purpose of developing the primary system, anticipate its allotment for the current and one succeeding year by the issuance of road certificates.

Should any county vote to issue bonds to anticipate its allotment from the primary road fund, the county is authorized to make such tax levy as may be necessary to meet principal and interest of the bonds.

7. No bonds shall be issued by any county with maturity postponed more than fifteen years, nor shall any bonds be sold for less than par plus all accrued interest.

8. The primary roads can be built straight through towns of less than 2,000, but no permanent surfacing is to be done out of the primary road funds in cities.

9. The state highway commission is authorized to co-operate with the board of supervisors for the purchase of road material or road machinery desired by any county, and to pay for same out of the primary road funds.

10. Establishes a secondary road system consisting of the county roads outside the primary system. This system to embrace about ten thousand miles. The secondary road system also comprises the township roads of which there are eight thousand miles within the state. All existing road funds outside the primary fund are after July 1, 1920, dedicated to the secondary roads and such funds are increased by the spreading of the two-mill road building levy, heretofore applied to farm property only, over all property within the county, including that in cities and towns.

11. Township trustees are authorized to levy an additional tax not to exceed two mills on all taxable values in the township for the development of the township roads of the secondary system. This is not compulsory.

SEWERAGE AND SANITATION

Legislature Orders City to Stop River Pollution.

Worcester, Mass.—The bill which requires the city of Worcester to remove offensive sewage from the Blackstone river and the resolve which directs the state department of health to investigate the condition of the river have been approved by Gov. Coolidge. The long-standing controversy between Worcester and the towns along the Blackstone valley will now come to a satisfactory conclusion. For years the pollution of the Blackstone river has been notorious and although from time to time individuals have made some move to relieve the situation, no benefits have ever come from their efforts and the pollution has continued as before. The original sewage disposal plant, which is now in operation, was installed under the authority of an act passed by the Legislature in 1886. Owing to the growth of the city the plant was increased in size from time to time, but the condition of the river has constantly grown worse. Last year it was officially stated by the state department of health that the condition of the river was never so bad. The new plant will be of the Imhoff type. The system has been approved by the state department of health and the department will supervise all plans and specifications before the work of installation is begun. The new system is to be installed before January 1, 1924, and the city of Worcester is required to expend not less than 200,000 a year until the plant is completed. It is estimated that the city of Worcester must expend nearly $1,500,000 in the enterprise, although there will be a substantial gain to the city in operating expenses over the present inadequate system. The law provides that the failure on the part of the city of Worcester to install the plant by the time specified, or to expend the money as required by the bill shall be prima facie evidence of negligence on the part of the city in any action for nuisance or damages brought against it. The city is ordered to remove all offensive and polluting properties from its sewage before it is turned into the river and the state department of health is required to make frequent investigations of the condition of the river and at any time to require changes or enlargements in the plant if it is deemed necessary. It is further provided that failure on the part of the city to comply with the directions and the orders of the state department of health shall be prima facie evidence of the existence of a nuisance under the provisions of the act. A most important feature of the new bill is that it requires the Attorney-General to bring action against the city of Worcester upon the request of any town situated along the river whenever it is claimed that a nuisance exists. Under the old law it was necessary for any town along the river which might be aggrieved to bring action in the courts and to defray all expenses of the prosecution. This proved so expensive in the few cases instituted that the towns were forced to quit the fight. But under the new law the state, through its highest legal department, must bring and prosecute any infringement of the law.

Eliminating Vaults and Surface Wells in Toledo.

Toledo, O.—An unusually good record, it is announced, has been made by the bureau of sanitation of the division of health, in the elimination of nuisances. Two of the worst sources of diseases, in the opinion of the division of health, are outside vaults and surface wells. While more and more of Toledo's residents are installing sewer connections and substituting city water for surface wells, there are parts of the city that are still thickly dotted with these disease spreaders. The bureau had succeeded in getting 203 outside vaults and 125 surface wells abandoned and filled up since January 1. During all of last year 92 surface wells were abolished and 204 outside vaults were replaced by modern sanitary facilities. More has been accomplished therefore in last five months than during all of 1918. This has been done entirely by moral suasion. No resort has been made to prosecutions. This result was achieved partly through the scheme of using the winter's accumulation of ashes and rubbish for filling the wells and vaults. The sanitary inspectors report that owners almost universally took this suggestion with favor and used this method of disposing of their rubbish and meeting the sanitary requirements at the same time. In 1915, when a sanitary survey of Toledo was made by Dr. Carroll Fox, a representative of the United States Public Health Service, it was estimated that there were 10,000 vaults in the city, and 4,000 to 5,000 surface wells. Arthur A. Greenbaum, chief of the bureau of sanitation, estimates that about 3,000 outside vaults have been abandoned during the last five years, but that probably a like number of new vaults have been built in the new sub-divisions that have opened during that time. He concludes, therefore, that there are still about 10,000 outside vaults within the city or its immediate environs, and about 3,000 surface wells.

WATER SUPPLY

City Penalized For Using Excess Water.

Jersey City, N. J.—Jersey City is the first municipality in the state to be penalized for failure to comply with the act of 1917, limiting the amount of water which a city may divert from a river or other stream of water. The attorney general has entered judgment in the Supreme Court to the amount of $22,285 against this municipality

for excess diversion from the Rockaway River. The law allows the drawing of 100 gallons a day for each inhabitant of a city and a penalty of $1 a million gallons, in excess of this rate. The computation on which Jersey City was penalized was based on the census of 1905, and the amount of the judgment covers the years from 1912 to the present year. Attorney general McCran's action is the result of a suit brought by the state against Jersey City in which the latter made the contention that the water supply act of 1905 did not apply to it. The court struck out this contention as no defense and allowed the filing of the judgment, which has just been carried out.

To Vote on $1,800,000 Filtration Plant.

Sacramento, Cal.—An ordinance calling for a bond election on June 26 for the purpose of creating a bond indebtedness of $1,800,000, to cover the cost of the erection of a filtration plant to obtain a clear domestic water supply for the city of Sacramento from the Sacramento river has been passed by the city commission. The bonds are to be of $1,000 denominations, running for 40 years, retired at the rate of $45,000 each year. The interest is to be 4½ per cent.

Water Company Wins Pollution Case Against City.

Niagara Falls, N. Y.—The court of appeals has advised corporation counsel Robert J. Moore and manager Huy of the Western New York Water company that the court has affirmed the injunction obtained by the private water company against the city restraining the latter from dumping effluent from the municipal filtration plant into the upper Niagara River. It was in 1915 that the Western New York company obtained the injunction from the supreme court. Appeal was taken to the appellate division, which later sustained the injunction by a divided vote, two of the five justices dissenting. Then appeal was taken to the court of appeals. The appeals acted as a stay of execution of the lower court's order and the city has since continued to dump the effluent into the river off the pumping plant. The private company contended in this case that the effluent was carried by the river currents down stream and into the intake of the private company's plant, polluting its source of water supply. To comply with the injunction order the city will now have to make connections at the filter plant with the city sewers, into which the effluent can be diverted.

STREET LIGHTING AND POWER

Power Development Plan Vetoed.

Albany, N. Y.—Governor Smith has disapproved the bill of senator Sage, regarding water power development. In doing so, the governor gives the following reasons: "The bill seeks to amend the Conservation Law, by creating a new commission to be known as the Water Power Commission, and conferring upon it certain duties of investigation as to the cost of the development, transformation, transmission and distribution of electrical energy created by the water powers of the state. As far back as 1907, an act was passed authorizing and directing the State Water Supply Commission to devise plans for the progressive development of the water power of the state for the public use, under state ownership and control. In 1911 the State Water Supply Commission was abolished by act of the legislation, and all of its duties turned over to the Conservation Commission. The Conservation Commission made a detailed study of the water power of this state, and submitted such comprehensive plans for the development thereof as required by the act of 1907. The legislation failed of enactment, but the result of that study is still with the Conservation Commission, and the duty of devising plans for the progressive development of the water powers of the state now rests with the Conservation Commission. We have had legislative committees which have collected enough data upon this subject to fill any room in the capitol. Too much money has already been expended on investigation, and this particular bill calls for an appropriation of $100,000. The report of these investigations, which is exhaustive enough to warrant the state development of its surplus waters without further delay, is on file with the State Conservation Commission. I regard any further investigation along the lines proposed by this bill as a useless waste of public funds. Action and not investigation, which at best only brings about delay, is what the people of this state are looking for. It is well known that the difficulty about the development of the water powers of this state rests in the differences of opinion as to how it should be done. Personally, I favor its development, its ownership and its control by the state itself, for the benefit of all the people. There are those who believe in its development by the state and its utilization by private interests through lease or purchase. I hold that the water powers of this state are the property of all the people, and that, when developed, the people themselves should be the beneficiaries. I can see nothing which this can do except authorize the expenditure of more money and cause the waste of more time."

Consumers Boycott Light Company to Help Strike.

Denison, Tex.—Electric lights furnished by the Texas Power and Light Company were turned out by every business house in the city and practically every residence because of a strike by electricians employed by the Texas Power and Light Company and the Dallas Light and Power Company. Union men of Denison requested that all patrons of the electric light company cut out their lights in sympathy with the striking union men and a majority of the people complied with their request. All churches of the city cut out lights. The newspapers used gasoline engines for power.

GOVERNMENT AND FINANCE

Boulder Appoints New City Manager.

Boulder, Colo.—W. D. Salter, director of public service, has been appointed city manager of Boulder, at a salary of $4,000 a year, by the city commissioners to succeed E. O. Heinrich, who resigned to go to San Francisco. The change will be effective June 15. Applications totalling 110 were received from all parts of the country for the position. It is understood that director Salter had not entered any formal application.

Franchise Tax in New York Declared Valid.

Albany, N. Y.—The appellate division of the Supreme Court, Third District, in an unanimous decision, has decided that corporations in New York State subject to the franchise tax of 3 per cent., based upon "the entire net income," are not entitled to deduct the amount of tax paid to the federal government on account of excess profits before computing the amount payable to the State. With respect to the State statute, the court said: "This is not an income tax; it is a franchise tax. It is a tax for the privilege of doing business in a corporate form in the State of New York, and the only relation of the federal act to the statute of New York is the basis for the computation of the State tax. The State franchise tax thus assessed bears equally upon every like corporation within New York. It does not constitute a double franchise tax, though the national government makes use of the same foundation in levying an income tax." The original ruling of the State Tax Commission, that no deduction of federal taxes would be allowed in computing the 3 per cent franchise tax, is therefore upheld.

City Employes Organize Consultative Council.

Bradford, England.—The Bradford city council has organized a joint consultative board to consider at regular intervals, questions of wages, hours, and working conditions, and to take necessary steps to prevent differences and misunderstandings between the corporation and its employes. The corporation is the largest employer of labor here, having nearly 7,000 employes—school-teachers,

clerks, and employes in the various public services, such as tramways and the municipal gas, electric and water plants. The consultative board will consist of 32 members, 16 appointed by the corporation, and 16 by the respective sections or groups of employes. The scheme will not in any way interfere with the liberties of the corporation on the one hand, or the rights of the unions on the other. The board will represent all sections of the employes, and the unions will, as heretofore, have full power to approach the respective committees of the corporation upon any matters they desire to bring forward. This scheme is in line with the recommendations of the well-known Whitley Committee, for the establishment of National Industrial Councils. Such councils are now in process of formation for most industries, including tramways, gas, water, and electricity, and the draft of a plan for a national council for all employes of local authorities other than the four trading undertakings named, has been formulated by a committee from the large municipal associations on the one hand and representatives of 12 large trade-unions on the other. The Bradford local supply was formed after consultation with the Minister of Labor. Already, it is stated, other municipalities are considering the formation of similar local boards.

FIRE AND POLICE

Air Ships for Fighting Forest Fires.

San Francisco, Cal.—The government has converted part of the war-time air fleet into a national forest patrol, with dirigibles, scout planes, flame extinguishing bombs and sky-riding firemen to save the billions of feet of timber annually destroyed by forest fires. The experiment is being launched in the Cleveland and Angeles national reserves in California, the U. S. Forestry service and the army working together. Successful there, it will be extended to the other 145 reservations throughout the country as fast as districts can be organized. Under this system, fire fighters will be rushed to incipient blazes it formerly took hours to reach. Bombing planes will smother small fires. Trained fire-fighters will be lowered by rope ladders from anchored dirigibles. And balloon sentries, in communication with forest posts by wireless, will hang over danger areas. The first of these sentries is on the job at Arcadia, Cal. Daily he soars to his 3,000-foot-high post. Then at ten each morning, two planes leave March Field, near Riverside, following routes from which the heavy forest can be scanned for over one hundred miles. A second patrol covers the district in the afternoon. In these planes the observers carry maps on which the forest is ruled off in squares, keyed by plainly visible landmarks and villages. A discovered blaze is immediately marked in the corresponding square on the map. The machine pilot then swoops low over the nearest village, drops a parachute message asking the finder immediately to phone the information to the district supervisor, or goes back to report personally. All residents have been informed about these messages and how to co-operate. Meantime, the dirigible at Arcadia remains aloft throughout the day, in wireless touch with ground stations where trucks suitable for hard mountain travel stand ready for instant use and a squad of ten enlisted men is prepared to rush into the forest with extinguishers, axes, picks, tanks of water and canteens.

Three Platoon System Vetoed; Two Platoons Coming.

Albany, N. Y.—Governor Smith has vetoed the Blakely bill to provide for a three-platoon system for firemen in first-class cities, after affirmative action by a referendum. "I must withhold my signature from this bill," the governor set forth in a veto memorandum, "for the reason that it creates the policy of local government with which I am not in accord. In other words, the bill provides machinery for overruling the decision of the duly elected public officials on a purely administrative matter by popular vote. The power to give relief lies with the elected officials, and, so far as the city of New York is concerned, I am informed by the city representative at Albany, that the board of estimate and apportionment is now considering and working out a two-platoon system."

New York, N. Y.—Fire commissioner Thomas J. Drennan has received from the board of estimate an appropriation for 150 additional firemen as a preliminary to establishing the two-platoon system in the department. Before July 1 the two-platoon system will be established in 100 companies, affecting about 2,500 men. It is estimated that the first cost will be about $1,500,000 a year, and that when the system has been extended by the entire department, the cost annually will be about $6,000,000. The system is to be tried first in the fire companies in congested parts of the city, where there are few hours of idleness and much heavy fire fighting. The details of the system have not been entirely worked out. Commissioner Drennan said that in the main, the two platoon system would call for day and night shifts. The tentative plan calls for fourteen hours of night duty and ten hours of day duty. The platoons will alternate weekly. "The question as to when the shifts will go on duty is still a matter of debate," said Commissioner Drennan. "We want to get a morning work hour that will be convenient to the men, and will, at the same time, make for effective work. If we make the morning hour for reporting 8 o'clock, the men will have to come from their homes just when the work-day tide is at flood, and this may mean delay. If they report at 9 o'clock they will miss the heavy traffic, and by missing it, contribute just that much to lessening the morning congestion on the transportation lines. As to how many men will be needed to make the change throughout the department, there is difference of opinion. It is possible that it will require 1,100 men to bring the department up to efficiency. Perhaps we could get along with a smaller number. For instance, we could have skeleton companies in the outlying districts. It can be done, but there is another side of the question. Let the department, working with a skeleton company, lose a frame house, entailing the deaths of a mother and child say, in Ozone Park, and it would receive more censure than if it had lost a building in Broadway. The problem is complex and must be carefully worked out." Under the present system the men work on a single shift. They have every fifth day off, and three twelve-hour leaves in each month.

MISCELLANEOUS

U. S. Plans Air Terminals in Cities.

Washington, D. C.—The Government's plan for co-operating with municipalities in the establishment of airplane landings and creating a system of aerial highways, capable of use for military, postal, and commercial purposes, has been announced by the Air Service of the United States Army. It was also made known that the Air Service, co-operating with the Post Office Department, hoped in the near future to aid in the laying out of air terminals in at least thirty-two cities and towns from the Atlantic to the Pacific, and from the Canadian border to the Gulf of Mexico. These points range in size from New York City to Flatonia, Texas, and have been selected for their fitness as places on a national system of air lanes. The new landing fields are to be of four classes, according to the importance of the city, or its position with regard to military, postal or commercial uses. No field should be proposed, the announcement states, unless it is capable of expansion, because the Air Service is looking ahead to the day when aerial navigation will challenge the older means of transportation. The announcement deals with official policy, specifications for landing fields, and classification of them. Blueprints have been prepared, showing the size and shapes of the four kinds of proposed landing fields. Local uses of the fields are to be fixed by mutual agreement.

"The development of aviation in the United States," the Air Service announcement reads, "will be along military and commercial lines. The Air Service, although concerned primarily in the military phases of aviation development, is nevertheless vitally interested in co-operation with and assisting any other legitimate agencies which are engaged in

aerial activities. Foremost among these is the Post Office Department, which now finds it necessary to establish throughout the country terminal or way stations for its aerial mail deliveries, and which is jointly associated with the Air Service in presenting this project to the attention of the municipality.

"The establishment of landing fields throughout the country through co-operation with the Government agencies and the cities concerned, will certainly operate to the advantage of both the Government and the city, because in the rapid development of commercial aviation, those cities which have provided the primary facilities for operation of aircraft in their vicinity, will have paved the way for local benefits, resulting from the development of aerial inter-city transportation, express service, mail service, emergency service and local photographic mapping of aerial protection."

The fields are to be established in accordance with articles of agreement to be entered into between the United States Government and the municipality. Neither the Air Service nor the Post Office Department will deal with any private societies or associations.

"At present," continues the announcement, "the Government can co-operate in the establishment of municipal flying fields at cities where the Post Office Department has established an aerial mail station and where the Air Service cross-country routes require intermediate stations. A study of the immediate requirements would indicate that the establishment of flying fields will be confined at present to the following cities and towns:

"Boston, New York City, Richmond, Va.; Raleigh, N. C.; Columbia, S. C.; Augusta, Ga.; Macon, Ga.; Atlanta, Ga.; Kissimmee, Fla.; Mobile, Ala.; New Orleans, Baton Rouge, La.; Beaumont, Texas; Flatonia, Texas; El Paso, Texas; Texarkana, Texas; Columbus, Ohio; Tucson, Ariz.; Phoenix, Ariz.; Yuma, Ariz.; Bakersfield, Cal.; Fresno, Cal.; Buffalo, Albany, Columbus, N. M.; Kansas City, Mo.; Oklahoma City, Okla.; Uniontown, Penn.; Daytona, Fla.; Cleveland and Chicago.

"Although the Government must confine itself at present in co-operating in the establishment of municipal landing fields at cities where the aerial mail service requires stations or where stations are required for cross-country use of the Air Service, it is not intended that such limitation should in any way restrict the establishment of other landing fields at cities and towns where local conditions would seem to warriant such action."

The general specifications provide that the locale of first-class fields should be such that transportation to and from the heart of the city would not ordinarily take longer than half an hour. They should be adjacent to a good highway and near the city car lines. They should have public service utilities, such as electric light, water supply, and sewerage, should permit of expansion and should not be in a position where they are likely to be shut in by future building operations. The minimum size of any field should be such as to allow a 600-yard runway in every direction, with no interfering obstacles. The shape should be square or rectangular. Second-class fields are those whose shape is neither square nor rectangular, and in the third class are those which are less desirable, owing to size and location and fail to meet the general specifications. Fourth-class flying fields are those which can be used only for landing in case of emergency. Should the municipalities mentioned decide to co-operate with the government, the government will furnish an expeditionary steel hangar to be erected at the expense of the municipality. The landing field will be prepared at the expense of the municipality, which will also bear the expense necessary for personnel and the maintenance of field and equipment, exclusive of airplanes.

Municipal Markets in U. S.

Washington, D. C.—According to a report about to be issued by the Bureau of the Census, Department of Commerce, municipal markets were maintained during the fiscal year 1918, by 128 of the 227 cities having more than 30,000 inhabitants. These 128 cities reported a total of 237 markets, 174 of which did a retail business, 14 a wholesale business, and 49 conducted both retail and wholesale business. The market employes numbered 540. The largest number of markets shown for any one city is 19, for New Orleans; Baltimore reported 11; New York, 9; Wilmington, Del., 8; Pittsburgh, 6; and Los Angeles, Milwaukee, Washington, D. C., and Columbus, Ohio, 5 each. No other city maintained more than 4, and the majority operated only 1 each. Since the Bureau of the Census is authorized by law to collect statistics only from those cities which have populations of more than 30,000, it was impossible to extend the inquiry to the many smaller municipalities which also maintain markets. The subject, the Department says, is a timely one, in view of the abnormally high prices now charged for most foodstuffs, and the information presented in the report will be of great value to cities which have not yet established municipal markets, but are contemplating doing so.

LEGAL NEWS

A Summary and Notes of Recent Decision—Rulings of Interest to Municipalities

Prohibition of Poles and Wires—Ordinance Becomes Contract.

(Ill.) Ordinance prohibiting erection or repair of poles and wires in streets and alleys is prima facie within the city's power.—City of Sullivan v. Best, 121 N. E. 565.

Mere fact that ordinance prohibiting erection and repair of wires and poles in streets and alleys could not be enforced against company holding franchise, so to use the streets and alleys, would not invalidate ordinance as to others.—Id.

Where a city enacts an ordinance licensing a public service company to maintain poles and wires in its streets for the necessary and reasonable conduct of its business, the ordinance, when accepted and acted upon, becomes a contract which the city cannot arbitrarily abrogate.—Id.

Expired Railway Franchise—Renewed by Ordinance—Continuous Trip.

(U. S. Sup.) For a city after the franchise of some of the lines of a street railway company have expired to pass an ordinance to continue in force for a year unless sooner repealed, with penalties for its violation, for continued operation of the company's system, with fares and transfers over the various lines, whether or not having a franchise, amounts to a grant to the company for further operation of the system, during the life of the ordinance.—Detroit United Ry. Co. v. City of Detroit, 39 S. Ct. 151.

The obligation of the franchise contract for a line of a street railway company, fixing the fare on such line at five cents without transfer, is impaired, in the case of a continuous trip beginning on a non-franchise line and extending over it and a franchise line, by an ordinance requiring all such service for five cents.—Id.

Unnecessary Obstruction by Sewer Construction.—Cost of Restoring.

(N.J.Ch.) The word "travel," in P. L. 1903, p. 164, § 7, and P. L. 1907, p. 29, § 5, providing that the construction of sewers should not unnecessarily obstruct or impede travel, includes all the methods ordinarily in common use by which people on foot or with horses, wagons, and power trucks may traverse public streets, and includes travel by means of street cars.—Public Service Ry. Co. v. Frazer, 105 A. 387.

P. L. 1903, p. 164, § 7, and P. L. 1907, p. 29, § 5, providing that sewerage commissioners in the construction of sewers should not unnecessarily obstruct or impede travel, means "reasonably necessary"; but the interruption of the use of a street railway for eight months was unreasonable, if there was a method by which such an interruption could have been avoided.—Id.

Where contractors adopted a method of constructing a sewer which unnecessarily interrupted travel for eight months on a street railway line, the actual cost of taking up the tracks, laying temporary tracks, and restoring the situation, should be paid by the contractors, under P. L. 1903, p. 164, § 7, and P. L. 1907, p. 29, § 5.—Id.

Covenants, in a contract with sewerage commissioners to construct sewers, to protect and maintain in place existing structures, held not made for the benefit of a street railway or other third persons, but for the security of the commissioners.—Id.

NEWS OF THE SOCIETIES

June 9-13.—AMERICAN WATER WORKS ASSOCIATION. Thirty-ninth annual convention, Iroquois Hotel, Buffalo, N. Y. Secretary, J. M. Diven, 47 State street, Troy, N. Y.

June 17-19.—TRI-STATE WATER AND LIGHT ASSOCIATION OF CAROLINAS AND GEORGIA. Ninth annual convention, Greenworth, S. C. Secretary treasurer, W. F. Stieglitz, Columbia, S. C.

June 17-20.—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual meeting, St. Paul-Minneapolis. Secretary, Charles W. Hunt, 33 W. 39th St., New York, N. Y.

June 23-26. — SOUTHWESTERN WATER WORKS ASSOCIATION. Annual convention, Coates House, Kansas City, Mo. Secretary, E. L. Fulkerson, 617 Washington St., Waco, Tex.

June 24-27. — AMERICAN SOCIETY FOR TESTING MATERIALS. Twenty-second annual meeting, Hotel Traymore, Atlantic City, N. J. Secretary, University of Pennsylvania.

June 24-27.—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual convention, Kansas City, Mo. Secretary, Gen. Fire Marshal James McFall, Emergency Fleet Corporation, U. S. Shipping Board, Philadelphia, Pa.

Aug. 26-28.—LEAGUE OF CITIES OF THE THIRD CLASS IN PENNSYLVANIA. Twentieth annual convention, Allentown, Pa. Secretary, Fred H. Gates, city clerk, Wilkes-Barre, Pa.

Aug. 27-29.—VIRGINIA STATE FIREMEN'S ASSOCIATION. Thirty-third annual meeting, Charlottesville, Va. Secretary, E. K. Landis.

Oct. 27-30.—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting, New Orleans, La. Secretary, A. W. Hedrich, 169 Massachusetts ave., Boston, Mass.

Nov. 12-14.—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, New Orleans, La. Secretary, Charles C. Brown, Springfield, Ill.

American Society of Mechanical Engineers.

The spring meeting of the American Society of Mechanical Engineers will be held at the Hotel Statler, Detroit, June 16 to 19. The following features will be included in the professional program:

On Monday afternoon, following a business meeting, the society's committee on aims and organization will present its preliminary report on a general meeting. This committee, consisting of over thirty members, including representatives from the various sections of the society and seven members at large, has held several meetings. The object of the committee has been to bring out the sentiment of engineers throughout the country as to what should be the controlling elements in an engineer's work under present conditions; what constitutes engineering as a profession and what are the really important functions of an engineering society in its service to engineers and the public.

The Tuesday morning session will be devoted to the subject of research under the auspices of the research committee of the society. Several papers and reports will be presented on this subject because of the impetus given to it by war conditions.

Industrial relations will be the subject of the afternoon session, including several addresses by men of national reputation. The session will be a symposium by leading engineers on the factors dominant in the labor situation, with an interchange of views on the conditions necessary for industrial peace.

Wednesday's session will be in charge of the Detroit local committee and of several of the sections of the society. It will be devoted to technical papers. There will also be a gas power session with papers on oil engines.

There will be miscellaneous technical sessions on Thursday, one of which will be for the discussion of fuels, including powdered fuel and oil fuel.

The Detroit local committee is arranging many events for the entertainment of those attending. Among those will be an afternoon and evening devoted to a boat ride on the lake during which dinner will be served.

American Association of Engineers.

The annual convention of the American Association of Engineers was held in Chicago May 12 and 13. Among the subjects discussed were: Employment problems and opportunities, proper compensation, salary schedules and society relations. Ninety delegates from thirteen of the chapters and three clubs attended, although the attendance was 186 at the biggest session.

A number of changes were made in the constitution, as follows: A national practice committee is authorized, to report on questions of ethical policy and conduct, a grade of candidate junior is added; chapters are to recommend grading of candidates; junior members may now vote but not hold office; the latest past-president is to be a director; the board is authorized to make mutual agreements with other societies. (This confirms the affiliation plan carried out with the Cleveland Engineering Society.)

Warm discussion developed over the proposal to fix the entrance fees at $5 or $10. The present by-law was retained; entrance fees, therefore, will continue to increase automatically by $2 for each 500 members above 1,000, the count to be made in December and fixed for a year. Fear that the fees would be so high as to keep out younger members gave way to the idea of the increased service that could be rendered through the larger income.

After an explanation of the similarity in work of the Engineering Institute of Canada with that of the association, by Fraser S. Keith, secretary of the former body, it was voted to leave the Canadian field to the institute and to co-operate fully with it. A telegram was received from the Oregon Engineering Society asking for a proposal either to enter as a chapter or to make joint membership possible.

A. M. Van Auken, chairman of the committee on compensation of the Chicago Chapter, presented a comprehensive report, containing schedules. (These were summarized in last week's issue.) Adoption was not asked for, but it was recommended that the national body use the data and schedules in a nation-wide study and seek to formulate a more comprehensive schedule.

A recommendation was adopted providing that abstracts of all laws applying to engineers and surveyors, which degrade and hurtfully affect the engineer, should be collected, published along with suggestions for better laws in the interest of the public and the good of the profession, and should receive the widest publicity. The St. Louis Chapter presented a schedule for the municipal engineers of that city, which was indorsed.

H. G. D. Nutting, in his paper on "Ways and Means of Obtaining Proper Compensation," indicated five ways which may be used to help the man who cannot develop sufficient initiative along selling lines. His suggestions were: Increase the demand; limit the number by license; limit the number of technical graduates (questionable); union methods (questionable); limit the fake correspondence school courses; limit the fake employment agencies with alluring offers.

F. H. Myers, speaking on the employment department, indicated that 10% of the dues is now spent on this activity. From 300 to 350 members are on the list to receive the bulletin of positions open. Circular letters to employers get 5% returns. For the week ending May 10, twenty-one men were placed in positions averaging $150 per month, at a cost of $45. Had these men gone to employment agencies the cost would have been $1,890.

The next annual convention will be held in St. Louis. The results of the letter ballot for officers are as follows: President, F. H. Newell; vice-presidents, W. W. DeBerard and F. A. Evans; new directors, W. W. K. Sparrow, P. E. Harroun, R. Burnham, F. D. Richards, A. A. Matthews and E. F. Collins.

National Highway Traffic Association.

The National Highway Traffic Association held its annual meeting in New York City, on May 14, following substantially the program already outlined in these pages. The general subjects discussed were: The organization and development of highway transport, the proper construction and control of the highways necessitated by motor express service, and the control of traffic on feeder roads.

NEW APPLIANCES

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations.

NEW HEAVY OIL ENGINE.

Of Hvid Type with Simplicity Feature of Design.

The new type "M. V." heavy duty oil engine manufactured by the Pittsburgh Filter & Engineering Company, embodies the well-established method known in Europe for many years as the Brons principle, and in the U. S. as the Hvid principle. This motor is designed to combine the economy of the Diesel type with mechanical simplicity. The motor is entirely independent of any carburetor, hot bulb or plate, spark plug, high pressure air compressor and storage tanks, fuel pump or spray valve. The compression is carried to approximately 500 lb. per sq. in. and the motor is started from cold, without pre-heating and put under full load in a few seconds. This motor will burn any grade of the cheaper fuels, from kerosene to the heaviest of fuel oils; the same fuel serving for starting. In the design of the type "M. V." engine, the aim has been to combine simplicity of construction with accessibility, in order to reduce the operating attention.

The "M. V." engine is of the inclosed type, and the design has adhered as far as possible to the thoroughly tested practice of modern high-speed Diesel engine. The principle of operation is as follows:

Suction Stroke: The piston moving downward, pure air is drawn into the cylinder through the inlet valve, also a small amount of fuel oil, which is under control of the governor, is drawn into a small cup within the combustion chamber. Communication between cup and combustion chamber is maintained by a series of small holes. The fuel oil is supplied to the cups by gravity from a tank a few feet above the cups. Fuel oil to this tank is delivered by a small plunger pump driven off the engine shaft and the level kept constant by means of an overflow. This overflow returns the surplus of oil to the main fuel storage tank. At the lower end of the stroke the inlet and fuel valves close.

Compression Stroke: On the return of the piston to its upper center the air is compressed to approximately 500 lbs. per square inch. The rise of temperature during the compression distills the more volatile portion of the fuel and at the upper center this vapor flashes into flame and the rise of pressure within the cup drives the fuel into the compression chamber for combustion.

Expansion Stroke: On the down stroke of the piston, after the fuel is burned, the charge expands and the pressure fall gradually to the end of the stroke.

Exhaust Stroke: During the next upward stroke of the piston the exhaust valve opens and the products of combustion leave the cylinder, completing the cycle.

In general design, the features of the "M. V." type engine are simplicity and substantial construction.

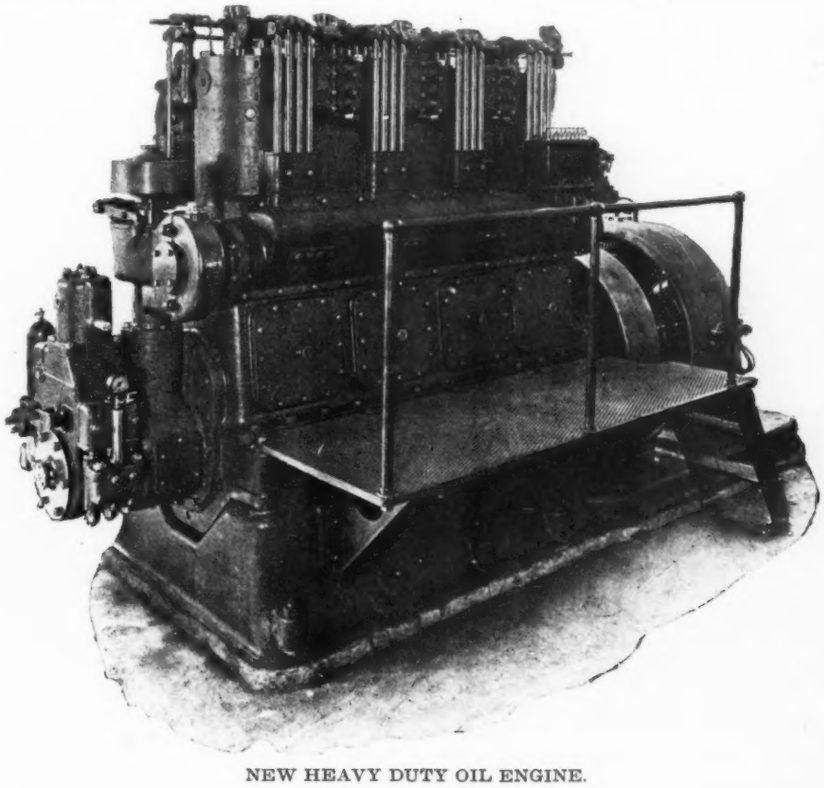
Not only is the crankcase inclosed, but the camshaft bearings, roller levers and gears run in a bath of oil. The camshaft can be removed by taking off the front cover. Accessibility of the crank pins is provided by very large openings in the crankcase. Air to the cylinders is admitted through slotted mufflers. Exhaust ells and header are water-jacketed.

Starting is accomplished by means of compressed air of about 125 lb. pressure per sq. in., each cylinder being provided with an air starting valve. The starting is assisted by compression relief valves. Starting and relief valve rockers are mounted on eccentric shafts and a single turn of the control lever brings the engine from starting into running order. This operation of the control lever also shuts off the fuel to the cylinders during the starting period. Compressed air for charging the starting tanks is supplied by a compressor driven off the engine shaft.

The amount of fuel required is regulated by a "Johns" governor mounted on a vertical shaft. Independent of this automatic regulation of a constant engine speed, a hand control lever enables to slow the engine down while running.

The lubricating system is complete and entirely automatic. The arrangement provides for the use of two grades of lubricants for the pistons and bearings respectively. The pistons are oiled by a Richardson-Phenix force-feed lubricator driven off the camshaft. This lubricator has individual feeds and a float valve for automatically keeping the lubricator filled when connected to an overhead reservoir, no attendance being required.

Main bearings, crank and piston pins are at all times flooded with a copious stream of clean, cool oil by a plunger pump driven off the engine shaft. The oil is initially forced under pressure into the main bearings, and through drilled passages of the crankshaft into the crank pins, thence through the drilled connecting-rod to the piston pin. The oil after leaving the bearings is collected in the crank pit, flows to a strainer, and from here a small plunger pump delivers it to a Richardson-Phenix filter. Leaving the filter the oil passes through a cooling coil and is used over again.



NEW HEAVY DUTY OIL ENGINE.

EXPANSION JOINTS.

To Protect Pipe Lines on Construction Work.

The C. H. & E. expansion joint for pipe lines was designed to eliminate a frequent annoyance in construction work covering long ranges—the breakage of pipe lines due to expansion and contraction caused by temperature fluctuations. In highway work, particularly, where pipe lines must very often be of considerable length, this trouble is responsible for loss of time and money.

Each joint is made to allow for twelve inches of expansion and contraction. This is done by means of a brass pipe which telescopes into a casing through a gland or stuffing box. The pipe line is connected to each end of the joint, which thus becomes a part of the line. In such work, for instance, as the construction of water-bound macadam or concrete highways, or work where it is necessary to supply water concrete mixers over long distances, these joints are calculated to prevent breakage if placed from 800 to 1,000 feet apart.

These expansion joints may also be had furnished with an air chamber (as shown in the accompanying illustration), to take up the water hammer in the line. If every second or third joint on a line is equipped with this air chamber, the water hammer will be reduced to a minimum. This will also prevent breakage of hose, etc., when the water is suddenly shut off at the mixer or at any point of the line and will produce a steadier flow.

The joint is made by the C. H. & E. Manufacturing Co., Inc.

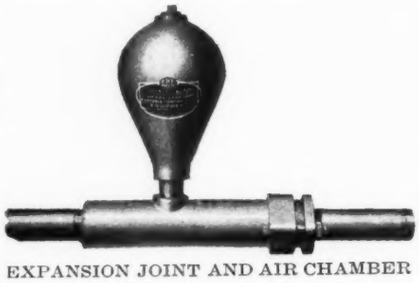
INDUSTRIAL NEWS

The Four Wheel Drive Auto Company, Clintonville, Wis., which manufactures F. W. D. trucks, has definitely decided to build a Canadian plant at Kitchener, Ontario. This announcement was made by president W. A. Olen, of the parent company, at a banquet tendered the Four Wheel Drive directors, by two hundred business men and officials of the Canadian city. The new company is to be capitalized at $200,000, $100,000 of the stock being owned by the Wisconsin Corporation. The directors are E. C. Kahel, W. T. Barrie, W. A. Cleghorn, Archie Kerr, H. J. Sims, Henry Nyberg and J. D. Cotton. Mr. Cotton was selected by the board for president, Henry Nyberg, vice-president and sales manager, Archie Kerr, secretary and W. G. Cleghorn, treasurer. A site is to be selected and building operations commenced immediately. The building, as now contemplated, will be about 200 by 120 feet. Additions will be made as business warrants.

The Four Wheel Drive Co. furnished the British Government with many millions of dollars worth of motor trucks and is looking forward to a large commercial business in the United Kingdom, as well as in the Colonies. This plant in Kitchener is the first step in the contemplated series which is expected to take care of the increased demand for F. W. D. trucks on the international market.

American-La France Engine Fights Fire in France.

According to an item in the Pontanezen Duckboard, the official publication of the American troops in Camp Pontanezen, an American fire engine helped prevent the spread of a dangerous fire in Brest, France. The entire interior of the Municipal Theatre was completely gutted. The loss runs into many thousands of francs. The blaze started in the dressing rooms during a rehearsal. No one was injured except for slight burns or bruises suffered by the American and



EXPANSION JOINT AND AIR CHAMBER

French firemen while fighting the flames.

U. S. Army fire department number one, located at Port de Commerce, near Q. M. warehouse number four at the docks, raced up to the theatre ready for action, but the French firemen did not want their aid, so the Americans returned to their quarters. At that time the blaze was confined to the stage, but it soon broke through two doors and in a few moments the audience section and roof was burning. Flames jumped thirty feet above the roof, which fell in. Colonel Loreau, of the French Mission, then appealed to the American fire marshal, Major Charles M. Tobin, and station number one made another run. The Americans quickly laid a line of hose 2,500 feet long from the theatre across Place de Wilson and down side streets through the iron gates to a U. S. Army pipe line at Port Foye, and in less than five minutes had a powerful stream of water drenching the flames. The pumping was done by an American-LaFrance gasoline fire engine received from this country only a few weeks before. It lifted the water 70 feet above the ground surface. The French firemen pumped their water from the harbor, uphill and into a tub by power from a small steamboat. A second hose was put into the tub and a gasoline engine set on a handcart then pumped the water from the tub through a line reaching to the theatre.

Two hundred and forty gallons of chemicals were used by the army firemen in protecting buildings in the rear end of the theatre, preventing the fire from spreading further.

NEWS OF THE SOCIETIES

(*Continued from page 428*)

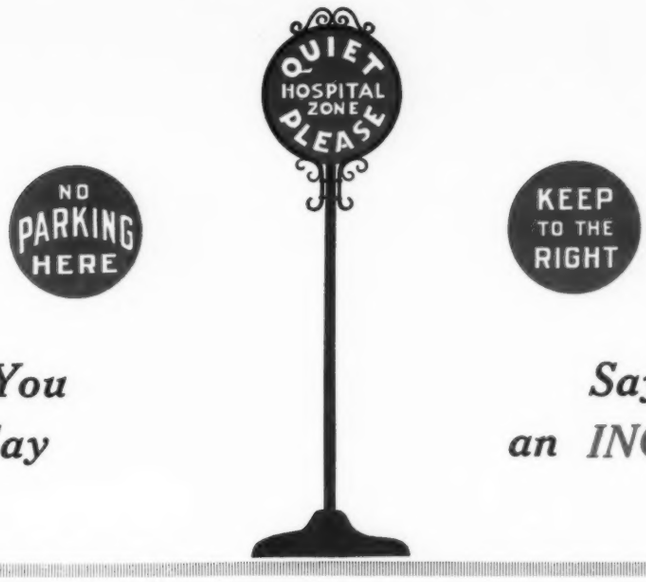
to the desirability of requiring franchises from motor express companies. It was stated that the principal reasons why motor express companies are failing are: Ignorance as to the cost of operation, and inability to raise prices on account of cut-throat competitors even if costs are known. It was the general opinion that legislation should be passed to limit the number of companies operating over any one route. Some, however, felt that franchises should not be given to motor transportation companies and they suggested a campaign of education as to the cost of operation.

At the evening session Arthur H. Blanchard delivered his presidential address in which he defined the subjects to be followed in the study of "Highway Transport Engineering." Addresses were presented on "The Townsend Highway Bill," by H. G. Shirley, secretary, Federal Highway Council, and "Highway Requirements," by W. G. Thompson, state highway engineer of New Jersey. A discussion on the control and construction of feeder roads was opened by E. J. Mehren, followed by George H. Price, president of the Heavy Haulage Co., of New York. A wide difference of opinion as to the feasibility and desirability of restricting heavy traffic on side roads was disclosed. It was pointed out that a very large percentage of present highways will not stand up under motor-truck traffic such as is proposed, with an allowed maximum load of 28,000 lbs. The fact was brought out that even legislative regulations at present in force are constantly broken, and it seems almost impossible to make the regulations effective.

The following officers were elected for the coming year: President, Prof. Arthur H. Blanchard; vice-presidents, David Beecroft and John T. Stanton; secretary, Elmer Thompson; treasurer, George H. Pride. The following directors were elected: Gen. T. Coleman du Pont, of Delaware; William P. Eno, of the District of Columbia; William P. Beatty, of Illinois; Charles Henry Davis, of Massachusetts; Walter R. Addicks, of New York; R. J. Corbitt, of North Carolina, and Philip A. Koehring, of Wisconsin.

The Society of Terminal Engineers.

The American Society of Terminal Engineers recently held its annual meeting in New York City. Francis Lee Stuart, chairman of the engineering committee, United States Railroad Administration, previously chief engineer of the Erie and Baltimore and Ohio R. Rs., was elected president. Other officers elected for the coming year are: Vice-presidents, John Meigs, E. H. Lee, Calvin Tomkins, Charles Whiting Baker and Maurice W. Williams; treasurer, W. Joshua Barney; secretary, J. H. Leonard.



Whatever You Have to Say

Say It with an ING-RICH Sign

An ING-RICH Sign Tells Its Story

Cheerfully, gracefully, quickly—and firmly. It tells it day in and day out; year after year. The ING-RICH sign marks the town which thinks of its citizens and of strangers. It makes the city safe and convenient—a place to be remembered. And when it **must** warn—it will **not** be passed by heedlessly and overlooked. An ING-RICH sign always talks as if it means business.

It's Bright. The color is brilliant and stays so. It stands out in dense traffic or against glaring billboards. It is seen easily—it has high visibility.

It's built, not smeared on. The porcelain enamel is fused into the iron by a special process—it's not merely painted tin. It is solid, substantial and durable. It laughs at the weather.

It's guaranteed for 10 years. We know it will last because it is built to last. It will not rust or fade or tarnish. Put up an ING-RICH and forget it for 10 years.

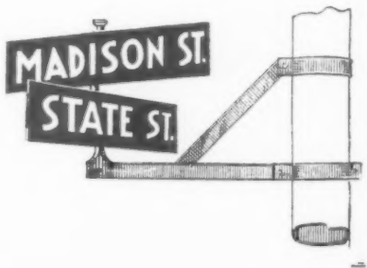
It's cheapest. Because it does not have to be replaced it is economical. Because it is guaranteed, there are no risks or disappointments.

It can say anything. ING-RICH signs are made for every kind of service—traffic, warning, street numbering and naming. Wherever they are used they may be relied upon to do their work.

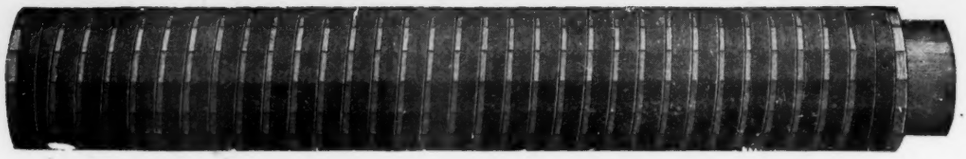
The sign above is a good example of **ING-RICH** quality and service. Two signs are supported back to back on a 39 inch pipe mounted on an 18-inch round base weighing 40 pounds. The rigid projecting frame protects it from damage. The signs are 15 inches in diameter, in two colors and with any desired wording. It is weather-proof, attractive and economical. It is versatile and finds many uses.

The Sign of a Good Sign is the Name

ING-RICH



Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

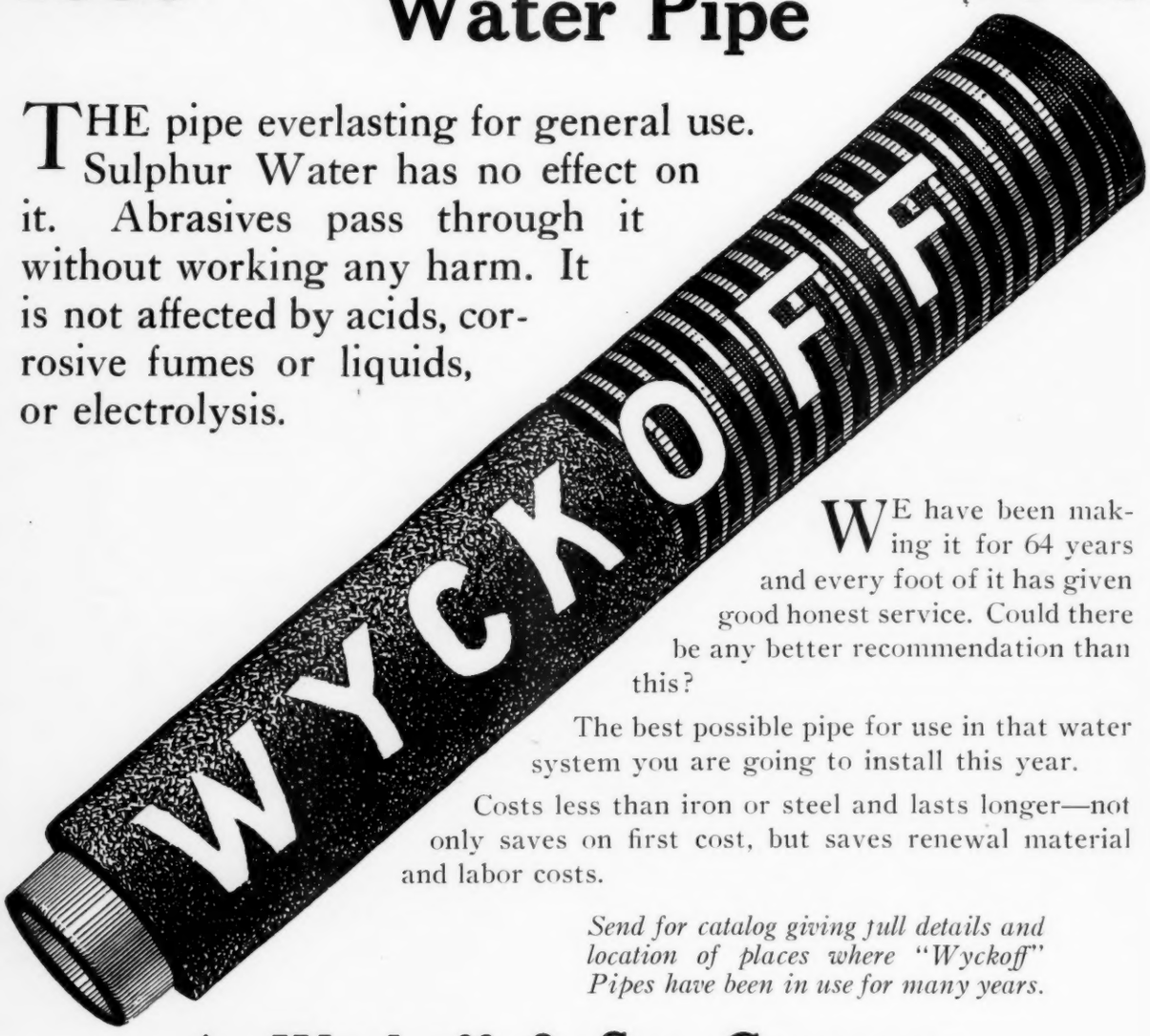


WYCKOFF

Wood Water Pipe

1855→ **←1919**

THE pipe everlasting for general use. Sulphur Water has no effect on it. Abrasives pass through it without working any harm. It is not affected by acids, corrosive fumes or liquids, or electrolysis.



WE have been making it for 64 years and every foot of it has given good honest service. Could there be any better recommendation than this?

The best possible pipe for use in that water system you are going to install this year.

Costs less than iron or steel and lasts longer—not only saves on first cost, but saves renewal material and labor costs.

Send for catalog giving full details and location of places where "Wyckoff" Pipes have been in use for many years.

A. Wyckoff & Son Company

Elmira, N. Y.